THE AEROPLANE

Incorporating
Aeronautical Engineering
Edited by - - THURSTAN JAMES

Founder and First Editor
(1911-1939), C. G. GREY

Proprietors :
TEMPLE PRESS LIMITED

Chairman and
Managing Director :
ROLAND E. DANGERFIELD

Head Office :
BOWLING GREEN LANE,
LONDON, E.C.1
Telephone : Terminus 3636
Telegrams :
" Pressimus London Telex."
Telex 23839

Vol. XCV. No. 2460 OCTOBER 24, 1958

Annual Subscription Rate: U.K. £4.15.0.
Overseas £5. Canada and U.S.A. $15.00

TWENTY-FIVE YEARS OF ROCKETRY

IN 1933 Mr. P. E. Cleator founded the British Interplanetary Society and on Friday last, October 17, he was honoured at the twenty-fifth anniversary dinner of that body which now holds a notable place among the leaders in the International Astronautical Federation. On the same day in Adelaide, Australia, Sir John Carroll, scientific adviser to the Admiralty and leader of the British delegation to the Commonwealth Advisory Committee on Scientific Defence, announced that Britain is developing a rocket motor capable of launching a heavy payload to a height of 500 miles. He added that it would be a year or two before Britain put up a satellite. It was obviously accepted by his hearers that the decision has been taken to launch a British satellite and from his remarks it seems that the primary use of the satellite will be to relay scientific information. How the picture has altered from those faraway days of 1934 when as the president of the B.I.S., Dr. L. R. Shepherd recalled, B.I.S.-men were referred to as a lot of cranks.

Among the distinguished guests at the dinner was Professor H. S. W. Massey, Quain Professor of Physics at University College, London, who is playing a notable part in the British contribution to the arrangements for the International Geophysical Year. In the course of his speech he made the noteworthy point that Pioneer only failed to reach the Moon by some 400 feet per second; it was this comparatively small difference in speed which was critical. In other words, by making sure next time that Pioneer II attains a speed 400 feet per sec. faster than its prototype we shall be sure of covering the other odd 170,000 miles of space.

Another distinguished visitor was Commander Hoover, U.S.N., who had read a paper to the Conference on Space Medicine earlier in the afternoon. He limited his toast to the achievement of manned space flight to a very few words. He is a man of wide interests and played an important part in project " Orbiter " from which the Vanguard project was developed.

In the course of a delightful evening not much was said about British participation in the exploration of space except in the most general terms. Indeed, we had expected to hear something said about next year's highlight, the organization by the B.I.S. of the tenth annual congress here in England of the International Astronautical Federation.

This forthcoming responsibility lights up the difficulties which encompass a society which has set out to promote the development of interplanetary exploration and communication by the study of rocket engineering, astronomy and other associated sciences. It is obvious that certain difficulties are inherent in activities largely financed by the State and which have as their primary objeetive the furtherance of military weapons. Some reference was made to this aspect by Mr. W. H. Stephens, a deputy director of the R.A.E., Farnborough, who made his speech in an individual capacity.

So far as this country is concerned, the development of rocket engineering has undergone tremendous expansion as a result of the decisions taken continuously after the War to develop, first British air-to-air guided missiles and then ground-to-air missiles and lastly the long-range ballistic missile from which most people assume that the first British satellite will come. These tremendous strides have come about as the result of work by teams largely built up in the firms of the aircraft industry and composed of propulsion engineers, electronic specialists, guidance experts, physicists and so on. The work of the giant telescope at Jodrell Bank has high-lighted the vital part that astronomers play in the co-operative effort.

It can be seen that the workers in this field are not only handicapped by the security restrictions on publicizing their work but also by being grouped among many bodies. This aspect became evident a year ago or so when in 1957 a conference was organized jointly by the B.I.S. and the Royal Aeronautical Society and held at the College of Aeronautics, Cranfield. A much weightier task has now to be undertaken, for at the beginning of September next, as we said earlier, the B.I.S. will have the honour of organizing the Tenth International Congress of the I.A.F. There are those who feel that the task should be shared with other bodies and the position is being examined.

When the range of subjects covered by the Conference is considered, and the seventy papers or so read this year at Amsterdam form a useful guide, it is understandable that the idea of organizing joint action with a number of bodies has influential supporters. Perhaps, this might be a case where one of those consortia, now so popular in aviation, should be formed. If sections of various learned societies existed for those of their members specifically interested in interplanetary flight, as does for instance the guided-flight section of the R.Ae.S., a consortium of such sections might be formed with the B.I.S. as the co-ordinating body.

So large a number of technicians from many societies will have to work together in teams to get a British satellite into the air that a really imaginative step of this kind might be the best way to organize the First International Space Conference in the United Kingdom.

D.

MATTERS OF MOMENT

Hawker Siddeley Changes

INTEGRATION of the aeronautical interests of the Hawker Siddeley Group into a single Aviation Division—as foreseen in THE AEROPLANE for September 5—has been announced by Sir Roy Dobson, the Group's managing director. In a recent statement Sir Roy has said: "Hawker Siddeley has merged all its aviation interests into one new division. These great names in British Aviation—Hawker, Avro, Gloster, Armstrong Whitworth, Armstrong Siddeley are now in this tremendously powerful single unit. This means that our new Aviation Division has research, design, development and production facilities of immense strength, second to none in the World. The world of air power stands on the threshold of exciting new 'things to come' in manned aircraft, missiles and astronautics. The new Aircraft Division of Hawker Siddeley is ready to match our leadership tradition of the past with leadership into that exciting future."

It is not yet known to what extent the various components will lose their separate identities and whether the present company names are to be retained to identify their particular products. It would seem highly likely, though, that these "great names" will continue to be used, for they carry World-wide respect—and in consequence would have a powerful influence on the sale of the Group's products overseas.

It would seem logical to expect from this announcement further integration on a broad basis. The announcement of Mr. Stuart Davies' appointment (THE AEROPLANE, September 5) was concerned with the heading of a project division. In Sir Arnold Hall, the Group have an internationally recognized figure from the world of research who would seem a natural choice for heading an integrated research division.

In a more recent statement, Sir Roy Dobson explains that the decision to set up separate Aviation and Industrial Divisions within the Hawker Siddeley Group has called for "distinct and specialized sales forces." He goes on to say that, faced with ever-increasing competition Britain "must continue to promote energetically if her products are to hold their present place in the World's markets." In this context Sir Roy has announced that Mr. William Humble, M.B.E., has been appointed International Sales Manager for the new Aviation Division.

Mr. Humble is widely known in the aircraft industry at home and abroad and for some years has been the Group's Regional Executive for the Near East and Pakistan. Having learned to fly in 1929, he joined the Reserve of Air Force Officers and became a member of Nos. 504 and 609 Squadrons in the, then, Auxiliary Air Force. In 1940 he joined Hawker Aircraft, Ltd. as a test pilot and was responsible for the flight testing of the prototype Tempest, Sea Fury and Hawker N7/46. He was appointed chief test pilot in 1948 and shortly afterwards became the company's sales manager. This post he held until moving to Cyprus in 1950 to look after the Group's affairs in the Middle East. Mr. Humble was educated at Repton and Cambridge and initially qualified as a mining engineer.

ROYAL ARRIVAL.—Her Majesty The Queen and The Duke of Edinburgh, accompanied by the Secretary of State for Air, Mr. G. R. Ward and the Chief of the Air Staff, Marshal of the Royal Air Force Sir Dermot Boyle, arrive at St. Clement Danes on October 19. More pictures are on page 606.

Roll-out of the X-15

DURING ceremonies attended by Vice-President Nixon, the North American X-15 atmosphere-research aeroplane was rolled-out on October 15 at Los Angeles. Also present on the occasion were officials from the U.S.A.F., U.S. Navy and the National Aeronautics and Space Administration (N.A.S.A.).

The X-15 has a span of 22 ft. and is 50 ft. long; it weighs 31,276 lb. including 1,300 lb. of instrumentation. Structure is mainly Inconel-X, titanium and stainless steel to withstand skin temperatures of up to 1,000° F. Hydrogen peroxide is used in the ballistic controls system and for fuel in auxiliary power units which supply electrical and hydraulic power.

The rocket engines use liquid oxygen and ammonia propellents. In the first test flights two Thiokol Reaction

TROPICAL STINGER.—Tactical trials of a Folland Gnat Mk. 1 were made in August in the Aden Protectorate. It was a standard Mk. 1, loaned by the Government of India and flown out in a Beverley. After the trials, the Gnat was sent by Beverley to the I.A.F. aircraft and armament test unit at Kanpur.

CONTENTS

MATTERS OF MOMENT ..... 602 an
NORTH AMERICAN X-15 (Pictures) .....
ST. CLEMENT DANES .....
NEWS ITEMS ..... 607 an
AIR TRANSPORT .....
SPECIAL SUPPLEMENT—The D.H. Comet 4 ..
THE FIGHTING SERVICES .....
TWIN-ENGINED WEIGHT-LIFTER (Omega BS-1
PRIVATE FLYING AND GLIDING .....
CORRESPONDENCE .....
WREN'S WROUNDABOUT .....
NOTES AND EVENTS .....

Motors XLR-11 engines will be used, the same type of engine as that used in the Bell X-1 aeroplane. Later, the Thiokol XLR-99 rocket engine of 50,000 lb. thrust will be installed.

A rocket-powered ejection seat gives the pilot maximum protection in case of baling-out above 60,000 ft. The pilot's cabin is air-conditioned and pressurized by a liquid-nitrogen system. The undercarriage consists of a twin-nosewheel and steel skids.

First flights of the X-15 will be made by Scott Crossfield, North American test pilot. Later, U.S.A.F. and N.A.S.A. teams will take over, headed by Capt. Bob White and Joe Walker respectively. The X-15 will be used to investigate man's reaction to space flight, the effects of weightlessness, acceleration and deceleration when leaving the Earth's atmosphere. It is expected to reach a height of 100 miles and speeds up to 3,600 m.p.h. Total cost of the programme, including three or four aircraft, will be $121.5 million. The first flight is scheduled for February next year at Edwards A.F.B., when the X-15 will be air-launched from under the port wing of a B-52.

Pictures of the X-15 are on page 605.

Bristol 188 Revealed

MENTION can now be made of the Bristol 188, which is a supersonic research aircraft built of stainless steel. This suggests that its first flight is near.

In THE AEROPLANE of June 6 some information about this aircraft was reported from a lecture given in Canada by Dr. A. E. Russell, Bristol chief designer. First news of the aircraft's existence was given as long ago as 1956, in evidence before the Select Committee on Estimates. It was then referred to as a "straight thin-wing research aircraft built in steel."

Obviously the ancestry of this aircraft goes back several years, and it may well have been intended originally for research associated with the Avro supersonic bomber, whose development was cancelled following the 1957 Defence White Paper.

If the Bristol 188 was connected with the Avro bomber, it is probably an aircraft with engines at the wing tips; this was to have been a feature of the Avro aircraft. A logical powerplant would be two de Havilland Gyron Juniors; the supersonic version of this engine, the D.G.J.10, has no other known application. Its thrust is reported to be in the five-figure bracket. Use of steel throughout the airframe of the Bristol 188 suggests that it is designed for sustained flight at Mach numbers above 2.25, which is generally considered to be the limit for light-alloy structures.

Advent of the Bristol 188 will be a big step forward for Britain in the research field. This aircraft should provide invaluable information for the development of Bristol supersonic airliners. It is only to be hoped that a reasonable number—at least five—of these aircraft have been ordered. The Fairey F.D.2 and Saunders-Roe S-R.53 programmes would have been of greater use if more aircraft had been available.

More Hope for Private Flying

THE news that Mr. Airey Neave, Joint Parliamentary Secretary of the Ministry of Transport and Civil Aviation, has been asked by the Minister to act as chairman of a Standing Joint Committee on Private Flying and Club-flying and Gliding is well received by the bodies concerned with such matters.

Some little while ago Mr. Neave said he would like to meet representatives of the organizations concerned, and a meeting was arranged, through the Royal Aero Club, to which representatives of the Club, the Association of British Aero Clubs and Centres, the Popular Flying Association, the British Gliding Association, the Guild of Air Pilots and Air Navigators, and the Guild of Air Traffic Control Officers were invited. Of these bodies all accepted except the A.B.A.C.

The terms of reference of the new committee (the secretary of which is Mr. L. C. Nash), are, "To assist the Minister of Transport and Civil Aviation in keeping under review all matters affecting the development of private and club flying and gliding in the United Kingdom."

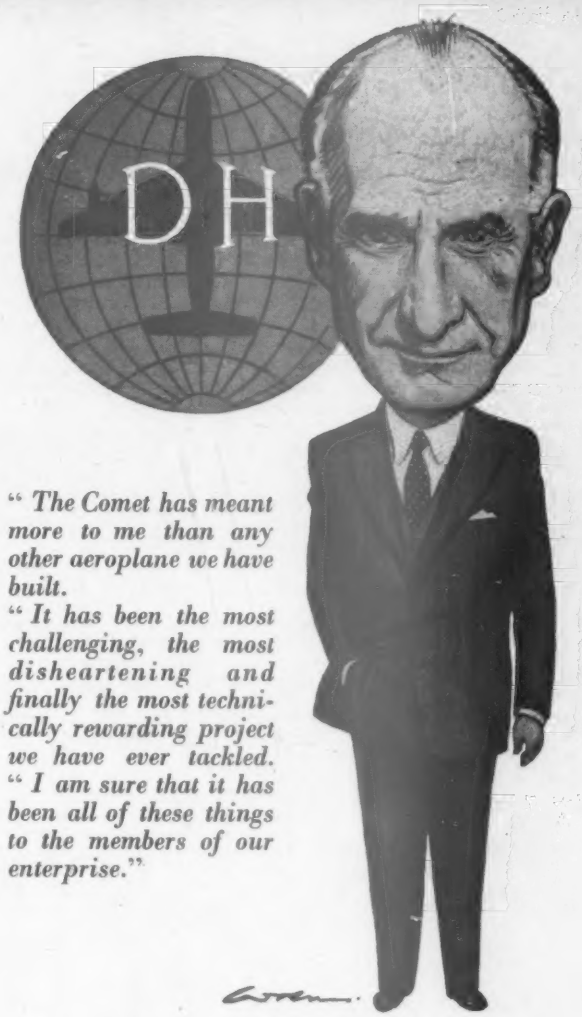
This should mean that the views of the private-flying movement will not be ignored in the framing of the Ministry's aviation policy generally. Existing contacts between the Ministry and private-flying organizations are not to be superseded by the new committee.

The R.Ae.C. in particular is encouraged by this step by the Ministry. It regards the committee as a top-level platform on which relevant matters can be decided, and feels that there will be closer co-operation when, for example, facilities and improvements for private flyers are requested. It wants to see—and who does not?—more modern aircraft for private flying, and generally more consideration shown to the private pilot. It is not proposed to ask for a Government subsidy, because the movement should be able to stand on its own feet if all bodies concerned show a united front.

Appointed as the R.Ae.C. representatives are Mr. J. J. Dykes, well-known private pilot and practising solicitor, and Mr. Maurice Imray, secretary of the R.Ae.C. Aviation Department. It is understood that Mr. Peter G. Masefield, P.F.A. president, will represent the Association at the new committee's first meeting.

Mr. Philip Wills, chairman of the B.G.A., who, along with Mrs. Ann Welch has been appointed as the Association's representative, considers that the new committee will provide an opportunity for getting the Government to adopt a different approach to the question of gliding. The Government's assessment of the value of sporting flying has been mainly based on the theory that amateur pilots are regarded as of semi-military value, whereas something should also be done to get a real light-aircraft industry under way and to ensure that the air is not solely monopolized by professionals. In nearly all countries abroad sporting flying receives substantial financial help on both social and economic grounds.

Composing the differences between some of the organizations involved in running private flying in this country might prove to be rather like composing the "Donner and Blitzen" polka, but it has got to be done.



"The Comet has meant more to me than any other aeroplane we have built.

"It has been the most challenging, the most disheartening and finally the most technically rewarding project we have ever tackled.

"I am sure that it has been all of these things to the members of our enterprise."

Capt. Sir Geoffrey de Havilland, C.B.E., A.F.C., Hon.F.R.Ae.S.

(B.O.A.C.'s New Comets, pages 610-631.)

Exercise "Sunbeam"

VERY similar to the 1957 exercise, this year's United Kingdom Air Defence exercise—code-named "Sunbeam"—took place between October 16 and 18. Designed to test Fighter Command's preparations against the initial attacks in the event of a global nuclear war, it was the first of these annual air-defence exercises to include the integration of surface-to-air missiles (SAMs) with the pilot-manned fighter forces, and the practising of radio-active fall-out measures at R.A.F. stations.

As in the previous year the raiding effort was concentrated into three main raid periods, of two to three hours' duration, in each 24 hr. The whole exercise lasted for 72 hr., with two reserve days in case there was exceptionally bad weather to cause the cancellation of raiding effort.

During the intervals between main raid periods Fighter Command units and other defence forces were stood down. This was not done to make the job of the defences easier, but mainly so that the attacking effort could be concentrated into 10 major raids of an average strength of 400-450 aircraft, and to avoid long hours of standby during little or no raid activity. Altogether, approximately 3,500 sorties were flown against the United Kingdom.

Raiding aircraft were provided by Bomber and Flying Training Commands, U.S.A.F.E. units based in the United Kingdom, the Fleet Air Arm, 2nd A.T.A.F. and 4th A.T.A.F. Types which took part in the raids included R.A.F. Valiants, Vulcans and Canberras; R.C.A.F. Sabre 6s and CF-100s; U.S.A.F.E. B-47s, B-66s and F-100s, and F-84s of of the Royal Belgian and Netherlands Air Forces.

With the disbandment of a number of Fighter Command squadrons during the past 12 months, there were fewer defending fighters in this year's exercise. All United Kingdom day-fighter squadrons are now equipped with Hunters and with the exception of one squadron with Mk. 5s, which are being replaced at the end of this month, they are all operating Mk. 6s. On the all-weather side, all but three squadrons are operating various marks of Javelin and the remaining Meteor NF.12 and 14 squadrons will be re-equipped by the end of January, 1959. There are now no U.S.A.F.E. fighters stationed in this country.

Under the overall control of Air Chief Marshal Sir Thomas Pike, K.C.B., C.B.E., D.F.C., A.O.C.-in-C., Fighter Command, "Sunbeam" also contained a civilian thermo-nuclear fall-out exercise—"Night Bird"—which covered the whole of England and Scotland from Friday midnight (October 17) until the Saturday afternoon. This latter exercise, organized by the Home Office in conjunction with the Royal Observer Corps, ran concurrently with the Command's fall-out practice, which included the study of the effect of such conditions on essential work at airfields, such as fighter turnround after a sortie.

In addition to its rôle in "Night Bird," the R.O.C. reported low-flying aircraft over Eastern England during a special low-level phase. For the benefit of Territorial Army L.A.A. and coastal R.O.C. posts, low-level raids were flown against targets on the east and south-east coasts by Nos. 2, 3 and 5 Civilian Anti-aircraft Co-operation Units.

The most outstanding development of the exercise was the integration of Bloodhound SAMs from R.A.F. North Coates into air-defence system for the first time. Speaking at a Press conference before the start of "Sunbeam," Air Chief Marshal Sir Thomas Pike said, "We try to send fighters to intercept bombers way out to sea and then the missiles take on what is left over. We shall not fire any missiles, but we can go right up to the point of fire and exercise the complete system."

In practice one controlling officer will have to decide whether he is to send a fighter, missile, or both, after a target. Allowances will also have to be made for misfirings, and non-hits.

There were again no guided missile-equipped fighters in the exercise and the interception techniques were basd on standard curve-of-pursuit tactics developed for cannon armament. But it is expected that Fighter Command Javelins will be equipped with D.H. Firestreak AAMs in the coming year.

Fighter Command Officers are now permanently posted to NATO radar stations on the Continent, and their early raid warning was used for the first time in this exercise. Stationed in France, Denmark, Belgium, Holland and Norway, these R.A.F. representatives are working in direct land-line contact with the United Kingdom early warning radar system so that details of an attack can be given to the defence forces and Bomber Command's deterrent that much earlier.

Provisional assessments of the exercise by Fighter Command indicated that encouraging progress has been achieved during the past year since "Vigilant." The percentage of successful interceptions of enemy bombers before they crossed the coast was greater than last year, and both Hunter and Javelin squadrons made interceptions up to 175 miles out to sea. Fighter pilots reported that the V-bombers of Bomber Command presented the most difficult targets to intercept because of their superior performance to any other attacking bombers.

On the second day of "Sunbeam," October 17, Mr. Duncan Sandys, Minister of Defence, visited Headquarters, Fighter Command, at Stanmore, and Mr. George Ward, Secretary of State for Air visited R.A.F. Horsham St. Faith. For the first time in the history of the R.O.C. a detachment was on duty in the Fighter Command Operations Room to record the movement of radio-active fall-out.

Seventh in SAC

AN excellent performance was achieved by Valiants of R.A.F. Bomber Command in the 10th Strategic Air Command bombing and navigation competition, which ended at March A.F.B., California, last week. Competing against 39 SAC Wings, one of the two Valiant Wings, led by Wg. Cdr. S. Baker, was placed seventh in the overall competition, while among the 164 individual crews taking part, the highest among the R.A.F. came ninth, and was commanded by Sqn. Ldr. R. W. Richardson.

Overall commander of the R.A.F. detachment was Gp. Capt. L. M. Hodges, the C.O. of Marham, who led eight Valiants, manned by crews from Nos. 90, 138, 148, 207 and 214 Squadrons, Bomber Command. The Valiants were organized into two Wings, and had their own transport and maintenance support, provided by Comets and Hastings of Transport Command. The Bomber Command contingent also included a Victor, flown by the A.O.C. No. 3 Group, Air Vice-Marshal K. B. B. Cross, but only the Valiants participated in the competition this year.

Their main opposition was provided by 108 Boeing B-47s, drawn from 27 Wings, and once again a Stratojet unit provided the winning crew (from the 306th Wing at McDill A.F.B.). In fact B-47s took the first three places, the fourth being taken by a B-52 of the 42nd Wing at Loring A.F.B. In all, 40 B-52s took part, from 10 Wings, together with eight obsolescent B-36s from two of the remaining Wings to operate this aircraft.

Radar bombing was against pinpoint targets at San José, California; Boise, Idaho and Butte, Montana, while the navigational legs were flown round a total distance of 2,836 miles. In their own class, competing only against the B-52s, the Valiants did particularly well, Sqn. Ldr. Richardson's crew, from No. 148 Squadron, coming third in the individual crew placings, and Wg. Cdr. Baker's Wing being placed third among the Stratofortress Wings. Two other R.A.F. crews were also in the first 10 of this category, and Bomber Command should have no reason to feel displeased with these results.

FIGHTER LINE-UP.—Gloster Javelin FAW. 4s of No. 23 Squadron and Hawker Hunter F.6s of No. 65 Squadron in the dispersal area at R.A.F. Horsham St. Faith. Both squadrons claimed a high number of interceptions during the exercise.

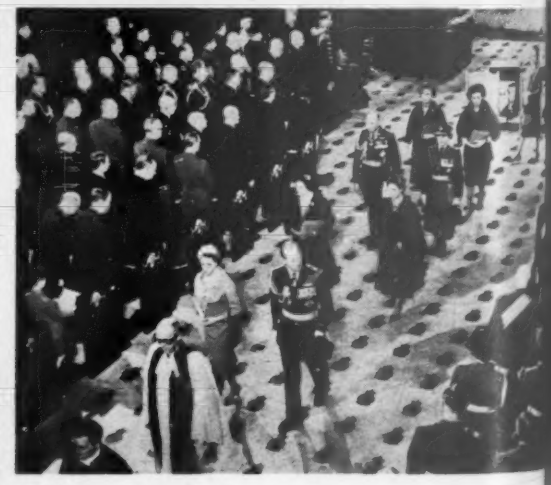
Photograph copyright "The Aeroplane"

For Manned Space Research

Levy-Artof Photographs

AN EXTREME PERFORMER, the North American X-15 (see also page 602) has many interesting features, including the single-wedge section of the pivoting-fin control surface; side-hinged air brakes in the fins above and below the rear fuselage; twin four-barrel Reaction Motors XLR-11 rocket engines; retractable steel landing skids (seen partially extended, bottom left) and twin nose-wheel undercarriage; twin outlets for APU exhausts behind canopy; fuselage-side bulges containing liquid-oxygen and ammonia propellents; and hydrogen peroxide "puff-pipe" reaction control system at nose and wing tips for ballistic flight. The X-15 will be launched from under the wing of a Boeing B-52.

ST. CLEMENT DANES



Photographs in black and white can only provide shadow images of the splendours of the reconsecration ceremony of the R.A.F.'s own church in the presence of Her Majesty the Queen and members of the Royal Family on October 19. In his sermon the Archbishop of Canterbury spoke of the Christian Church as providing a sure base for every adventure of the spirit. The Bishop of London began the ceremony of consecration by striking thrice upon the West door. The lesson was read by the Prince Philip, Duke of Edinburgh. The Air Council, not seen in the photographs, sat in the stalls along the West end. All ranks of the R.A.F. and its friends were represented in the congregation.

News of Aircraft, Engines and Missiles

CLUB COMPETITION.—The A.B.A.C. is organizing a competition for the three best suggestions on "What should be done to make the flying club, air centre and flying group movement more interesting and of greater benefit to the members." Suggestions may be of any length and must be clearly explained. There is no limit to the number of suggestions that may be submitted. The competition, first, second and third prizes for which are £10, £5 and £3 respectively, closes on November 20. Entries should be sent to the A.B.A.C. at 7c Lower Belgrave Street, London, S.W.1, marked "Competition."

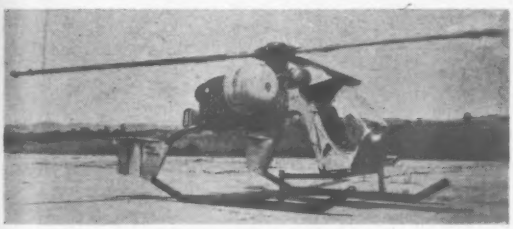
G.91 PRODUCTION.—The Fiat, Piaggio and Macchi concerns are all to take part in production of the Fiat G.91 light fighter; the Bristol Orpheus turbojet with which it is powered is being built by Fiat in conjunction with Bristol. The Magnaghi Co. and the French Messier concern are to supply hydraulic equipment, and Marconi, Smith, Lear and Sperry will supply instruments. So far 18 G.91s have been built, most of which are being evaluated by the Italian Air Force. The type will probably carry French Nord AA.10 or Martin Bullpup missiles.

MORE POWER.—The first C-130B Hercules was rolled out recently at the Lockheed Aircraft Corpn.'s Marietta plant. This version has four 4,050-e.s.h.p. Allison T-56-A-7 turboprops driving four 13 ft. 6 in. four-bladed Hamilton Standard propellers.

GERMAN SIKORSKYS.—The United Aircraft Corpn., of the U.S.A., has acquired a 43% interest in the German firm of Weserflugzeugbau, the capital of which has been increased from DM 4 million to DM 7 million. It is understood that the German concern will build Sikorsky helicopters.

U.S. TURBORAMJETS.—A development of the General Electric J93 (specified for the North American F-108 and B-70) is a turboramjet designed for operation at near-hypersonic speed around Mach 6. The J93 is a Mach-3 engine. Another turboramjet under development is a version of the Pratt & Whitney J58.

SHORT HOVER.—Since starting its hovering flight programme in mid-August, the Short SC.1 VTOL aeroplane has completed nearly 8 hr. of hovering in the test gantry. Throughout the trials the aircraft has been under the control of its three-axis autostabilizer system, which regulates "puff pipes" at nose, tail and wing-tips.



MULTI-PURPOSE.—The McDonnell 120 light helicopter is powered by three AiResearch GTC-85-35 compressors which supply air to the rotor tips.

Howard Levy photograph

FOR EARLY WARNING.—The California Division of the Lockheed Aircraft Corpn. has designed a new early-warning aircraft, designated CL-410, which is intended to replace the U.S.A.F.'s RC-121 radar-picket aircraft. Six major military contractors have joined with Lockheeds to form a "systems management team" to develop this aircraft, which incorporates the latest electronic-detecting, computing and communicating equipment. Lockheed also holds a U.S. Navy contract for advanced AEW research.

REACTOR PRODUCTION.—Two research reactors for Harwell are being built at the Vickers-Armstrongs factory at South Marston, near Swindon, and a third is being designed. A technical team of 100 men is engaged on nuclear projects at South Marston.

MAN IN SPACE.—A plan for a manned satellite has been mentioned by the director of the U.S. Advanced Research Projects Agency. A manned capsule will be launched within 2-3 years and remain in orbit for 24 hr. Re-entry will probably involve use of "retro-rockets" and a drag parachute large enough to ensure a safe descent. A sum of £14 million has been made available for the scheme.

ITALIAN TWO-SEATER.—A new company in Milan is building a light aeroplane, known as the F.400 Cobra, for touring, sporting flying and executive duties. It is to be powered by a Turbomeca Marboré II turbojet. A maximum speed of 374 m.p.h. is expected; the range, at 15,000 ft., should be about 650 miles.

HEAVY TRANSPORT.—The Breguet 765 Sahara, the military version of the Deux-Ponts, is seen here at Biarritz-Parme airfield. The French Air Force has ordered 15.

THE HON. ALAN BOYLE

WE regret to record that the Hon. Alan Reginald Boyle, fifth son of the seventh Earl of Glasgow, died at Blair Dalry, Ayrshire, on October 15. He was 72. He was among the first British pilots, gaining Aviator's Certificate No. 13 at Brooklands in 1910. His first aircraft was an Avis monoplane designed by Mr. W. O. Manning and built by the Scottish Aeroplane Syndicate, and he was later concerned with design work himself. During part of the First World War he served with the R. Scots Fusiliers, later becoming a balloon officer in the R.A.F. and winning an A.F.C. From 1932 to 1945 he was president of the Scottish Gliding Union; for 14 years up to 1945 he was convenor on the aviation committee of the Scottish Development Council.

NEW NOMENCLATURE.—The Minuteman long-range SSM weapon system has been designated XSM-80 by the U.S.A.F. The WS-117L reconnaissance satellite has been named Sentry.

LUTON RUNWAY.—A deputation from Luton has approached the Ministry of Supply for permission to borrow £320,000 to build a concrete runway at Luton Airport. The deputation included representatives from D. Napier and Son, Ltd., and Hunting Aircraft, Ltd.

MORE NEWS ITEMS ARE ON PP. 635-636.

Air Transport

B.O.A.C. in Trouble

AT the moment of going to press with this page it is uncertain whether or not the B.O.A.C. maintenance engineers are likely to agree to return to work early this week following the decision to set up a Court of Inquiry. This court, to be presided over by Prof. D. T. Jack, professor of economics at Durham University, was expected to start work last Wednesday.

The strike—which is generally believed by those outside the dispute to be by way of a showdown on both sides after many years of uncomfortable bickering—started on the night of October 13. Some 4,000 men were involved, 65 aircraft were initially grounded and it has been costing the Corporation something like £100,000 a day.

A go-slow had been instituted because of an "unsatisfactory" reply to a pay claim. Five men were apparently instructed to work overtime, but refused and are alleged to have been dismissed—though even this simple fact seems to be in dispute—after which resentment at this alleged action caused the men to walk out. On October 14 all B.O.A.C.'s services in and out of London Airport were brought to a stop, though some services were being continued by the expedient of arranging for the aircraft to make their turn-rounds elsewhere.

The maintenance engineers belong, altogether, to 17 different unions and for a long time the management of the Corporation has complained that certain shop stewards have "ruled the roost." On the other hand it seems to be generally agreed that the arrangements within the Corporation for industrial relations are too elaborate.

It was rather more than lucky for the Corporation that the first Comet 4 services were started before this trouble blew up.

A Pioneer's Impressions

AFTER so many people have written and spoken so many words about their impressions of flights in the Comet 4, it is refreshing to read something from the pen of one who was a leading figure in pre-War air transport—Major George Woods-Humphery, who flew as a passenger on one of the first Comet services across the Atlantic. He writes:—

"The first thing that really strikes one on starting a flight is the astonishing take-off and climb. On five recent occasions the writer timed and noted the take-offs, which were respectively of 30, 30, 28, 34 and 35 seconds' duration. Incidentally one of the 30-second and the 35-second take-offs were at approximately the maximum all-up weight. This can be compared with two timed take-offs in the DC-7, of 46 and 47 seconds.

"The next thing that strikes one is, of course, the very low noise level, and the complete absence of vibration. Also absent is the irritation in piston-engined transports caused by the constant changes, at least during the first few hours, in engine beats due to the operation of the various controls.

"The ventilation is quite the best ever experienced—the smoke of a cigarette rises immediately and vanishes in the ceiling, instead of being blown into another passenger's face. The heating control is also superior to anything yet experienced; a constant temperature seems to be maintained regardless of height or external conditions. The steadiness of flight, whether at high altitudes in clear air or going through 10,000 ft. of cloud, is quite unlike that in the average transport; the "bumps" which drop or lift one a few hundred feet seem, in the Comet, rather like the ripple of riding over cobble stones.

"Flying at 37,000 to 40,000 ft. provides quite a different view of everything; for example, one looks *down* on the Aurora Borealis, the sky is a different colour and the stars much brighter and more numerous.

"Initially one is inclined to be critical of the locations of the galley and bar, but, after reflection on the problems of service, loading and unloading, and the narrowing of the fuselage cross-section towards the forward and after ends, one comes to the conclusion that the best compromise has been made.

"The oxygen mask arrangements to cope with an emergency decompression are most ingenious. The equipment is completely hidden from view and yet immediately available, and automatically drops into position in case of need. In view of the extraordinary steadiness of this aeroplane in flight, it would seem that the provision of the usual sick-bags in every seat is unnecessary; these could be given out individually, if and as required, by the stewards or stewardesses.

"The eastbound flight over the Atlantic is really too short for a night flight, particularly starting from New York as early as eight p.m., since that hour of departure necessitates serving a meal after take-off and then there is only about three hours left for sleep. It is true that this departure time from New York allows an arrival in London at somewhere between eight and nine in the morning, but, after little or no sleep, few passengers will feel in a mood to undertake any activities, whether of business or pleasure.

"A better alternative, from the passengers' point of view, would be a daylight flight departing from New York between seven and eight in the morning—but this might make for awkward scheduling and might adversely affect fleet utilization."

The Jersey Battle

AFTER a debate lasting the whole day, on October 14, the States of Jersey approved by 30 votes to 19 the expenditure of £230,000 on the island's airport. An amendment to the effect that the question should be deferred for a year was lost by 28 votes to 21.

The money will be spent on extending the present runway from 4,450 ft. to 5,000 ft., making a new approach road and modifying existing lighting and telecommunications equipment. The Harbours and Airports Committee, who were seeking approval for the proposals, indicated that it might be necessary later to extend the runway still further to a length of 6,200 ft.

The question of extending the airport runways has been one of the most controversial the island has known for many years. Critics of the scheme have claimed that the local authorities were being forced to enlarge the airport at the demand of British European Airways because they planned to use Viscounts and, possibly later, Vanguards, on the run, when in fact there were aircraft available which could use the runway at its present length.

The supporters of the scheme pointed out that tourism provides about 25% of the island's total revenue.

DELHI-BOUND.—The Lockheed Electra seen here on October 9 at Keflavik Airport, Iceland — with the tail of a proving-flight Comet 4 on the right — was making demonstration flights while on its way to Europe, the Middle East and New Delhi, where the IATA annual general meeting starts next Monday. This was the first overseas flight by the Electra, which is due to arrive in this country on November 17 on its return flight from India.

Photograph copyright "The Aeroplane"

Boeing Approval at London

TERMS upon which the Boeing 707-120 will be permitted to use London Airport were made known by the Ministry of Transport and Civil Aviation on October 13. As expected, these impose a minimum height which must be reached before the aircraft passes over the nearest built-up area along the flight path. The conditions are substantially the same as those imposed by the Port of New York Authority at Idlewild (see our previous issue) and are set out by the M.T.C.A. in the following terms.

(1) A take-off technique acceptable to the Civil Aeronautics Administration of the United States will be adopted which will reduce noise disturbance on the ground to a minimum and which will enable the aircraft to achieve a height of not less than 1,000 ft. over the nearest built-up area along the flight path. In this connection P.A.A. have given an assurance that save on very exceptional occasions, they expect the aircraft to achieve a minimum height of 1,200 ft.

(2) When approaching to land aircraft will maintain an approach path not below that prescribed for approaches when using the Instrument Landing System or Precision Approach Radar facilities for the runway concerned and, where these are not provided, will maintain a glide path not less than three degrees.

The M.T.C.A. note also that the effects of smoke produced by the aircraft on take-off will be carefully watched. No figures are available to show what will be the effect of these regulations upon the take-off weights of the Boeing 707-120, but it seems unlikely that operations will be possible from London or Idlewild at the newly-approved gross weight of 248,000 lb.

At this weight, now approved by the C.A.A., the Boeing 707-120 requires a runway length of 10,200 ft. at sea level in I.S.A. to meet S.R.422. (This compares with the previously published Boeing figure of 9,600 ft. at 247,000 lb.). This is the distance to reach 35 ft. assuming one engine fails during the take-off. At the landing weight of 175,000 lb. the C.A.A. approved field length required is 5,980 ft. without using thrust reversers.

An Unexplained Accident

THE cause of the accident to the B.E.A. Viscount G-AOJA at Nutts Corner, Belfast on October 23, 1957, is recorded as "unknown" in the report of the public inquiry held earlier this year. The report, a comparatively short one, leaves no doubt that the investigation into the accident was an exhaustive one, and that all the possible causes were carefully considered. Not one fact emerged which could seriously be considered even as a clue to the possible cause.

The Viscount was flying to Belfast on a special charter to collect the Minister of Supply and his party, and representatives of the aeronautical Press, who had been visiting Short Bros. and Harland. It was operating with a crew of five and carried two passengers—a B.E.A. representative and his wife.

Weather at Belfast had not been good but was forecast to be improving. Although the captain considered diverting, first to Dublin and then to Aldergrove, he was eventually advised by the Zone Co-ordinator and Supervisor at Nutts Corner that he could probably make an approach without going below the B.E.A. minima. This he proceeded to do.

A normal GCA talkdown began at 16.45½ with the aircraft at 2,200 ft. on a heading of 285° and this continued normally until the aircraft was less than a mile from the runway. Soon after "three-quarters of a mile from touchdown" the aircraft was to the right of the centre line and shortly after it was "well right of centre line." The controller then said "if you're overshooting turn left five degrees for overshoot" to which the reply was ". . . overshooting."

Evidence was produced to show that the undercarriage and flaps were retracted, and the engines revved up in normal overshoot procedure. A second or two later the Viscount crashed, still within the boundary of the airport. All seven occupants were killed.

In the absence of specific indications of the cause of this crash, the inquiry paid particular attention to three possibilities —pilot error, interference with the control system and malfunctioning of the Flight System. There was no evidence whatever to suggest pilot error; no reason to believe that a screwdriver found in the wreckage had in any way jammed the controls; and no indication that a malfunctioning of any instrument or indicator led the pilot into a disastrous operation of the controls.

The report makes three recommendations on matters arising from the investigation. These concern the keeping of records of aerodrome lighting operations; the safe custody of items of wreckage awaiting examination; and the possibility of loose objects finding their way into vulnerable parts of an aircraft.

TRANSATLANTIC FRIENDSHIPS.—These two photographs serve to show the mounting rate of Friendship production on both sides of the Atlantic. Below, F-27s for Aer Lingus and other operators are seen on the final assembly line in the Fokker works at Schiphol. On the right, eight F-27s built by Fairchild are seen on the ramp at Hagerstown, Md. Fairchild have delivered ten F-27s to West Coast Airlines, Avensa, Quebecair and Piedmont.

"The Aeroplane" Photographic Montage

In the following 22-page special supplement, devoted to B.O.A.C.'s new Comets, we describe in detail the operating techniques and the development history of the de Havilland Comet 4, now in transatlantic service with the British Overseas Airways Corporation. Also included in this supplement is a three-page pull-out cut-away drawing, some sketches of the interior of the aircraft, and information about its Roll-Royce powerplants.

Operating the Atlantic Comet

WHEN B.O.A.C. started scheduled Comet operations across the North Atlantic the Corporation could be said to be re-continuing a programme of commercial turbojet flying which was started more than six years ago. But this new era will be a very different one—and with a very different kind of aeroplane.

Whereas the Comet 1, as eventually developed and proved for airline service, was, by present-day definition, a short-medium-haul aircraft, the Comet 4 is a medium-long-haul aircraft. Whereas, too, the first Comet was power-limited and had to be flown to a somewhat inflexible operating pattern, the Comet 4 is very amply powered and will not be seriously restricted by runway, cruising altitude, or temperature limitations even in fairly extreme conditions.

Over the North Atlantic it is, thanks to its moderate wing- and power-loading, able to fly out of all the terminal and principal alternate airports at more or less maximum weight and flight-planning is, consequently, that much simpler for the crews. In fact, the only serious restriction likely to be met in flight-planning and operating the North Atlantic Comet 4 services will be that concerned with the fundamental question—yet to be resolved—of whether a drift-up cruise rather than a stepped-climb procedure can be permitted by air traffic control.

Nevertheless, the similarity between the methods and philosophies of operation of the earlier Comet and of the much-developed and re-engineered Comet 4 is such that B.O.A.C. decided, a long time ago, that captains and first officers with route experience with the Comet 1 should fly the Comet 4s. So we have a situation, unique so far as the Corporation is concerned, in which a new Atlantic aircraft is being captained not by the old-timers on this somewhat specialized run, but by newcomers with experience of the aircraft rather than of the route.

Part of the reason for this change of policy is, no doubt, the fact that the decision to put the Comet first on the North Atlantic run—rather than on, for instance, the South African services—was made comparatively recently and after a great deal of fundamental crew re-training had been completed on the Comet 2E. The decision has had its effect, too, on the crew-complement planning for these first Comet services. On the flight deck there are two pilots, a flight engineer and a specialist navigator with experience of the North Atlantic and of the traffic-patterns and aids available.

But the important facts remain—that B.O.A.C. is employing flight crews with a considerable background of turbojet operating experience and that nothing can replace such experience. There is almost a fundamental difference, amounting to a new philosophy, in the thinking of those who have the responsibility for conducting turbojet flights—with the shorter time-scale; the need for the crews to be continually conscious of the fuel position; the different cruise-control methods at high Mach numbers and with rapidly changing weight as fuel is burnt; and the subtle differences in handling techniques.

Before going into some of the details of the flight-planning for long-haul Comet services, and of the problems which have still to be resolved in terms of navigation aids and operating methods, it will be useful, perhaps, to outline the basic pattern of these services.

First of all it should be explained that the Comet, equipped to B.O.A.C. standards, can, at its maximum gross weight of 158,000 lb. and with full tanks, carry a payload of some 10,000 lb. over a still-air distance of about 3,700 n. miles. With fuel reserves for diversion and holding, this range is equivalent to a practical sector distance of about 3,000 n. miles—sufficient for a non-stop flight from New York to London even when a favourable average wind-component of only about 20 knots is assumed, but not sufficient for a non-stop flight in a westbound direction unless the wind conditions are abnormal.

The North Atlantic schedules, therefore, assume one refuelling stop westbound—generally at Gander—and a

(*Continued on page* 611)

B.O.A.C.'s New Comets . . . .

(*Continued from page* 610)

non-stop flight eastbound on 85% of occasions during the year. Intermediate landings on this eastbound service are normally made, if necessary, at Shannon.

With an allowance of 15 min. for taxi-ing at each end, conservative sector times for the more generally flown stages are as follows: New York-L.A.P., 7 hr. 10 min.; N.Y.-Shannon, 6 hr. 25 min.; Shannon-L.A.P., 1 hr. 20 min.; L.A.P.-Gander, 6 hr. 20 min.; Gander-N.Y., 3 hr. 25 min.; L.A.P.-Keflavik, 3 hr. 20 min.; Keflavik-N.Y., 6 hr. 40 min.

Turn-round times are planned at 45 min., so the overall westbound time, via Gander, is 10 hr. 30 min. and the one-stop New York-L.A.P. journey time is about 8 hr. 30 min. Services leave London Airport at 10.15 hrs. local, arriving at New York at about 15.45 hrs. local (assuming no daylight-saving differences) and leave New York at 21.00 hrs. local, arriving at L.A.P. at 08.45 hrs. local.

Although long-haul transoceanic operations are necessarily made more difficult by the fact that the means of position-fixing are, at present, less positive than those on overland routes and because the meteorological information can be imprecise, the flights over the North Atlantic may, paradoxically, be somewhat simpler for turbojet than for propeller-driven aircraft. In the first place, the higher speed of the turbojet permits shorter-term, and therefore more accurate, terminal weather forecasts—and, for that matter, the use of "actuals," which, for the slower aircraft, might be virtually useless. In the second place there is, particularly on the western side of the Atlantic, a wide variety of alternates and no problems arising from the need to make traffic stops at specified points. Finally, the Comet will be making the flights over the more critical sectors as (virtually) full-tank operations, so there will be fewer alternative decisions to be considered when making the flight-plan.

B.O.A.C., through the Comet Flight manager, Capt. T. B. Stoney, proposes not only to simplify the methods of flight-planning—following work done by Mr. C. T. Farndell, the Comet Flight navigation officer—but to leave much more to the decision of the captain. His sole object is, after all, to reach the destination at either end as safely, quickly and economically as possible. After leaving either London or New York he has half a dozen alternates for use and is free to fly to any one of them according to the particular situation facing him hour by hour.

The Atlantic operations are in their early stages and there may be considerable modifications in the light of later experience, but it has been found practicable to adopt a flight-plan fuel-requirement formula which is based on a very simple flight "profile." This formula includes fuel allowances for the distance to destination at cruising altitude and then to the chosen alternate, where a descent is made to 1,000 ft.; at this height there will be a minimum reserve fuel weight of 5,000 kg. (or 1,360 Imp. gal.) still available. This overall reserve, coupled with that needed for the flight to the alternate, should be ample for any practical combination of en route changes in plan.

In addition, simple formulæ are provided for the quick assessment of the penalties involved in any alteration of flight-plan and a standard graph is available, for use on the flight deck, from which can be derived, more or less at a glance, the ranges which are possible with various fuel loads from different cruising or descent altitudes.

The practical results of flight-planning on this provisional standardized basis can be summarized for the more important sectors and these results are given in the table below.

Sector and distance (n. miles)	Alternate and distance (n. miles)	Max. overall wind component (W)=winter (S)=summer (knots)
London—Gander 2,041	Sydney (Nova Scotia) 286	—95 (W) —80 (S)
London—Gander 2,041	Goose Bay 340	—88 (W) —73 (S)
Keflavik—New York 2,309	Washington 203	—70 (W) —54 (S)
New York—London 3,049	Hurn 83	+23 (W) —

It will be seen that, on the London-Gander sector, an average overall adverse wind component of 95 knots has been assumed, while on the direct westbound flight a favourable component of only 23 knots has been allowed.

Obviously, a flight will not necessarily be a simple one involving immediate diversion and a descent into a holding pattern at the chosen alternate. The arbitrary 5,000 kg. minimum of reserve fuel (which will give a holding time of about 1 hr. 30 min. at 20,000 ft.) has been calculated on the basis of a great number of possible situations. For instance, some of this reserve might be used in holding at the destination —in which case the available holding time at the alternate will necessarily be cut down accordingly The average overall wind component might be more adverse than estimated and fuel might be needed for de-icing while holding at destination and before flying on to the alternate.

These are typical of the events during the progress of a flight and it is the captain's job, knowing his total reserves and assessing the weather, to decide how the situation should be met.

It should be stressed that the fixed minimum reserve is that on which a less-than-full-tanks flight-plan would be made in favourable conditions. Normally, at least during this earlier period of Atlantic operation, a full fuel load is always taken

COMET ALIGHTING.—This unusual shot of a Comet 4 touching down gives an excellent impression of the large flap area and the high angle of flap deflection used when landing; note also that split-flaps are employed under the engine bays.

Photograph copyright "The Aeroplane"

B.O.A.C.'s New Comets . . . .

on for the more critical sectors, such as London-Gander and Keflavik-New York. If the pre-flight sums, based on forecast winds, show a situation which leaves less than the 5,000 kg. (plus a final reserve of 500 kg.) after diversion and descent at alternate, then the flight-plan will be modified accordingly, with changes in the initial destination and/or the nominated alternate. Similarly an en-route variation in forecast conditions might involve a change of plan to ensure the retention of the basic fuel reserve after diversion.

There will be many occasions when a change for the worse in forecast winds is balanced by an improvement in (or a confirmed certainty of) the weather and traffic conditions at the destination. The penalties of an increasingly adverse wind component are not particularly excessive and can be read off a table or graph. For instance, even an increase in the average adverse wind component from 60 to 90 knots over a 2,000-n.-mile sector will involve a time penalty only of 32 minutes—or 1,550 kg. of fuel. The consequent reduction in the basic reserve, to 3,450 kg., would then be examined in relation to the conditions at the destination before any fundamental change of flight-plan is made.

Perhaps the best way of demonstrating the effect of a high cruising speed as opposed to sheer air endurance as such is to quote the fact that, in zero wind conditions, the Comet 4 can fly from London Airport to a point within 160 nautical miles of Gander and still return to Shannon with 2,300 kg. of fuel remaining after a descent to 1,000 ft. for the approach and landing.

The main problem for B.O.A.C. in the future of these Atlantic operations is one which applies with equal importance to all the half-dozen or so carriers who are, or soon will be, flying turbojet aircraft over this route. It is the vital one of effective air traffic control. All the airlines are going to be very severely handicapped if they have to use stepped-climb techniques with steps of 2,000, or even 4,000 ft. and are controlled to present-day standards of separation. With so many major airlines concerned with the problem on the most important air route in the World, something obviously will be done—and soon.

Even after agreement amongst the civil operators, however, there is still the immense amount of U.S. military traffic to be planned into a system. At present the military authorities tend to "block" a complete series of flight levels (say, from 35,000 to 40,000 ft.)—thus forcing the Comet to fly at uneconomic levels in certain areas and for quite long periods of time.

For the turbojet transports, the primary requirement is that of finding reliable means of separation which involve neither arbitrary altitude-levels nor impossible-to-achieve, follow-my-leader gaps in space. They must, therefore, be separated laterally—in a dimension which, though ample in area (and especially so by comparison with the six miles or so of possible vertical separation) has not so far been used because of the difficulty of fixing positions in space with sufficient accuracy.

We now have the means of more accurate position-fixing over areas where there are no ground-based, and few sea-based, aids. So far both Loran and Consol have been available and are normally used, but neither provides a continuous plot and both suffer serious inaccuracies in certain conditions. Dectra is by no means perfect as yet, but the transmitters are installed and, for the present, the system provides the only means of continuous position-plotting on the flight deck.

Whilst B.O.A.C. crew members are experienced in the well-tried methods of navigation there is keenness to adopt newer techniques and aids which are, at the moment, being evaluated. Such aids as Decca/Dectra and Doppler will be put into operational use as soon as they are known to be reliable and efficient. When that time comes more than just a simple navigation system may be achieved; their use will undoubtedly permit a system of lateral separation to be adopted once all operators are equipped to the same standard.

For the time being the Decca/Dectra equipment will, when installed, probably replace the 200 Mc/s Murphy distance-measuring equipment on the Atlantic run, but, later on, when Comet 4 services are started to the Far East and Australia, B.O.A.C. will have, as a consequence, a small problem on its hands. No operator likes to carry around unused equipment, even if there is room for it, and the Comets may sometimes be flying into London from New York and be put within an hour or so on, say, an out-going service to Tokyo. The Decca/Dectra equipment is, at the moment, of little value east or south of Europe (though there are Decca chains in India)—and the 200 Mc/s Murphy DME equipment is of no use on the Western Atlantic. Some method of rapid equipment change will no doubt be devised and the installation planned accordingly.

This detail point is mentioned because, for turbojet transports, a positive means of judging the moment for the start of let-down is especially important. Such a means is provided by DME and on the Commonwealth routes, where television and other problems do not affect the choice of frequency, 200 Mc/s equipment had been in successful use even before the introduction of the first Comet services in 1952. Conditions on the eastern

(*Continued on page* 620)

KEY TO CUTAWAY DRAWING

Fuselage

1. Dished front pressure bulkhead.
2. Nosewheel well with arched frame 3.
4. Crew emergency exit.
5. Window emergency exits (see near centre-section).
6. Centre-section rectangular box (forming fuel tank) with booms 7 and 8.
9. Centre-section tank separator baffles.
10. Connecting links (fuselage to centre-section).
11. Top connectors (centre-section to fuselage frame and to floor longerons 12).
13. Spliced joint to frame (rear 11).
14. Centre-section pressure floor.
15. Inclined end-plate to rear-fuselage underfloor.
16. Typical underfloor construction (H-crossbeams, and struts, with cargo hold between struts).
17. Hand luggage rack.
18. Ceiling lighting trough (right through).
19. Rear pressure bulkhead (domed).
20. Rear access door (starboard side—not shown).
21. Service and emergency door (starboard).
22. Tail bumper.

Wings

23. Rear spar booms embrace two-plate (two-ply) web.
24. Front spar booms and air intake yokes are all lugged and contained between two-plate web.
25. Outside angles.
26. Securing bolts (yoke to boom).
27. Rear-spar booms spliced to H-spar extension ("H" changes to channel-section).
28. Overlapped webs.
29. End of front spar.
29A. Beginning of auxiliary front spar 29B.
30. Outer-wing joint.
31. Aileron control-mechanism diaphragm into fuel tankage.
32. Fuel booster pump.
33. Fuel jettison outlet.
33A. Fuel-tank vents.
34. Engine front-suspension beam and links 35.
36. Transverse firewall.
37. Line of fairing (wing surface) over engine bays.
38. Jet pipe support-rails.
39. Dinghy stowages (same to starboard).
40. Stainless-steel engine bay firewalls with ram cooling-air 41A between them and wing structure.

Undercarriage

41. Main undercarriage operating jack.
42. Undercarriage lock connecting rod.
43. Main oleo strut.
44. Damper oleo strut.
45. Balance strut.
46. Linkage to servodyne 46A operating undercarriage door at 46B.
47. Nose undercarriage operating jack.
48. Steering arm.
49. Steering jack.
50. Undercarriage hinge point.
51. Self-centring mechanism.

Cabin Air System

52. Warm air off compressors of both engines to heat exchanger 53 via engine shut-off valves, flow controllers and non-return valves 52A, thence up to temperature control valve 54 and on to silencer 55, or from 53 through turbo-expander 56, up 57 and so to 55.
58. Same arrangement for starboard engines.
59. From silencer 55 up to 60, 60 to roof ducts 61, 61 right along aircraft fore and aft.
62. Airflow down frame, and out through louvres into cabin to provide cabin-air 63.
63. Some of air 63 passes up into trough 64 under the venturi action at 65 or 61, passing down 62 into cabin, and will form the recirculating air.
66. Remainder of air 63 passes through to wash-rooms, wardrobe and galleys with their floor-extractors, and right aft to extractor 67 at rear pressure bulkhead and right forward. Thence to atmosphere via underfloor and discharge valve in rear cargo hold.
68. Air into and out of cargo hold; then to atmosphere via 69 (repeat in rear fuselage cargo hold).
70. Two branches off air coming out of silencer 55, to give windscreen demisting 71 and cockpit warm-air supply 72.
73. Ground-conditioning duct emptying into cabin and charged from underbelly.
74. Instrument test connection; also pressure test connection and blow-off valve; also combined safety and inward relief valve; additional inward-relief valve. All on rear pressure bulkhead 19.
75. Ram cooling air into heat exchanger 53 (outlet via shutter at rear of 53).
76. Ram cooling air to rectifier 76A above each duct.

Anti-icing System

77. Hot air off the two engine compressors, through flow-control valves and controller, to trunk 78.
78. Trunk (with underside flap valve for cold-air entry) feeding main-plane leading edge 79 (out at wing tip).
80. Branch off 78 feeds double-skinned intakes 81, on the same principle as leading-edge anti-icing and forms cross-feed across aircraft to starboard engines. Also to tail unit at 82.

Flying Controls

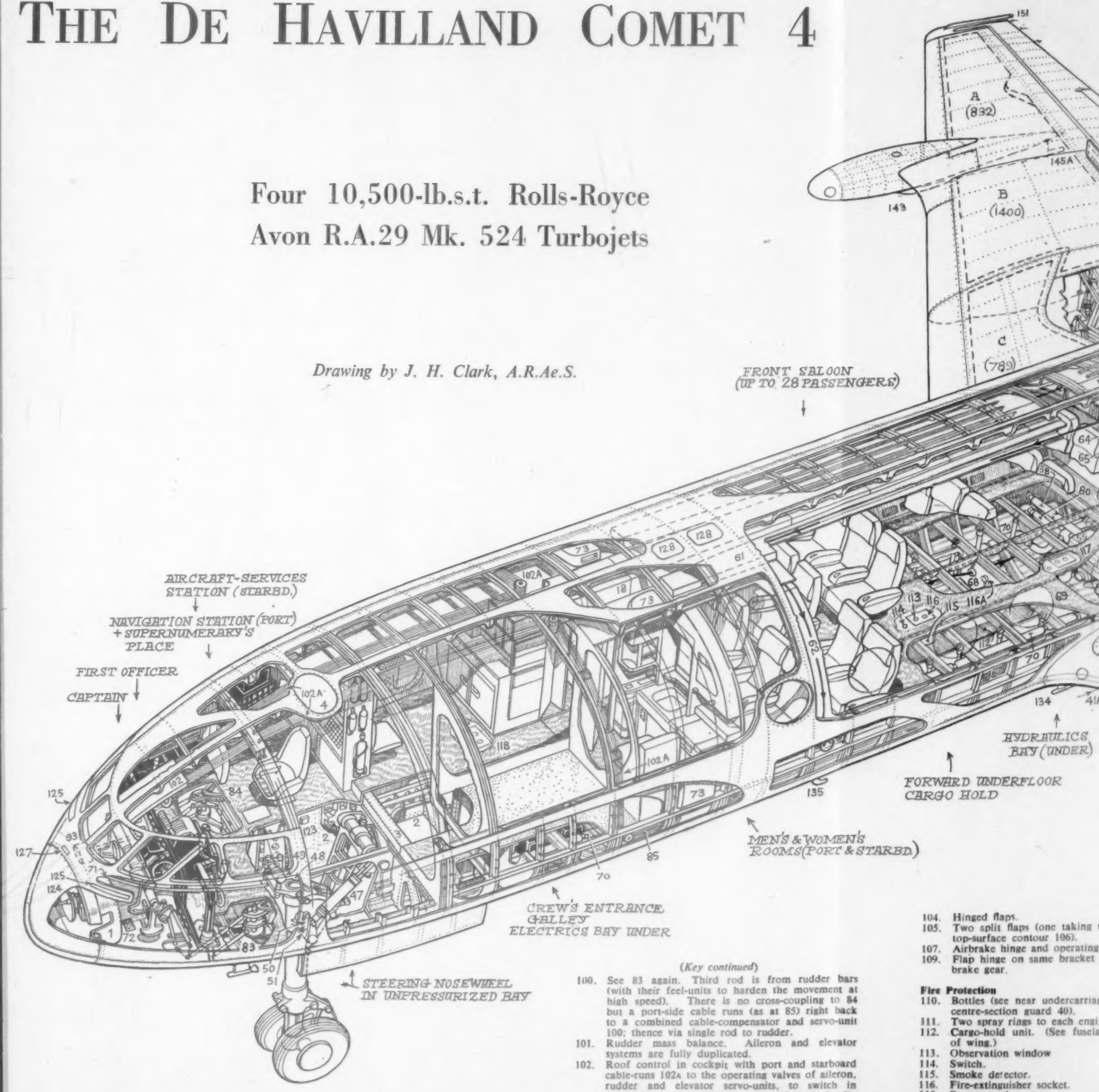
83. Three rods (from aileron, elevator and rudder controls) and stack of pulleys to which they connect with cross-coupling to 84. (Under First Officer's seat.)
85. From 83 and 84, aileron control wires run along fuselage (as at 85), between centre-section and shield 40, to cable compensators 86 (one for port line, one for starboard).
86. Cable-compensator drives servo-piston 87 through follow-up valve, to drive compensator 88.
88. Aileron cable compensators drive ailerons via cables along back of rear spar to bell-crank 90.
89. Coupler between the two aileron servo units.
91. Aileron operating rod.
92. Auto-tab rod.
93. See 83 again. One rod is from elevator control (cross-couplings to 84) and feel-unit 93 is connected up at 84 (the greater the airspeed, the greater the load imposed on the control column). Cables as at 85 pass along fuselage on both sides to pair of cable compensators 94 (see rear door).
94. Cable compensators operate the two follow-up pistons in the servo-units, 95.
95. Servo-units with two output rods 96 in duplicate to elevator via gear-change units 97.
98. Elevator mass balances.
99. Universal joints (to take up elevator dihedral).

THE

THE DE HAVILLAND COMET 4

Four 10,500-lb.s.t. Rolls-Royce Avon R.A.29 Mk. 524 Turbojets

Drawing by J. H. Clark, A.R.Ae.S.

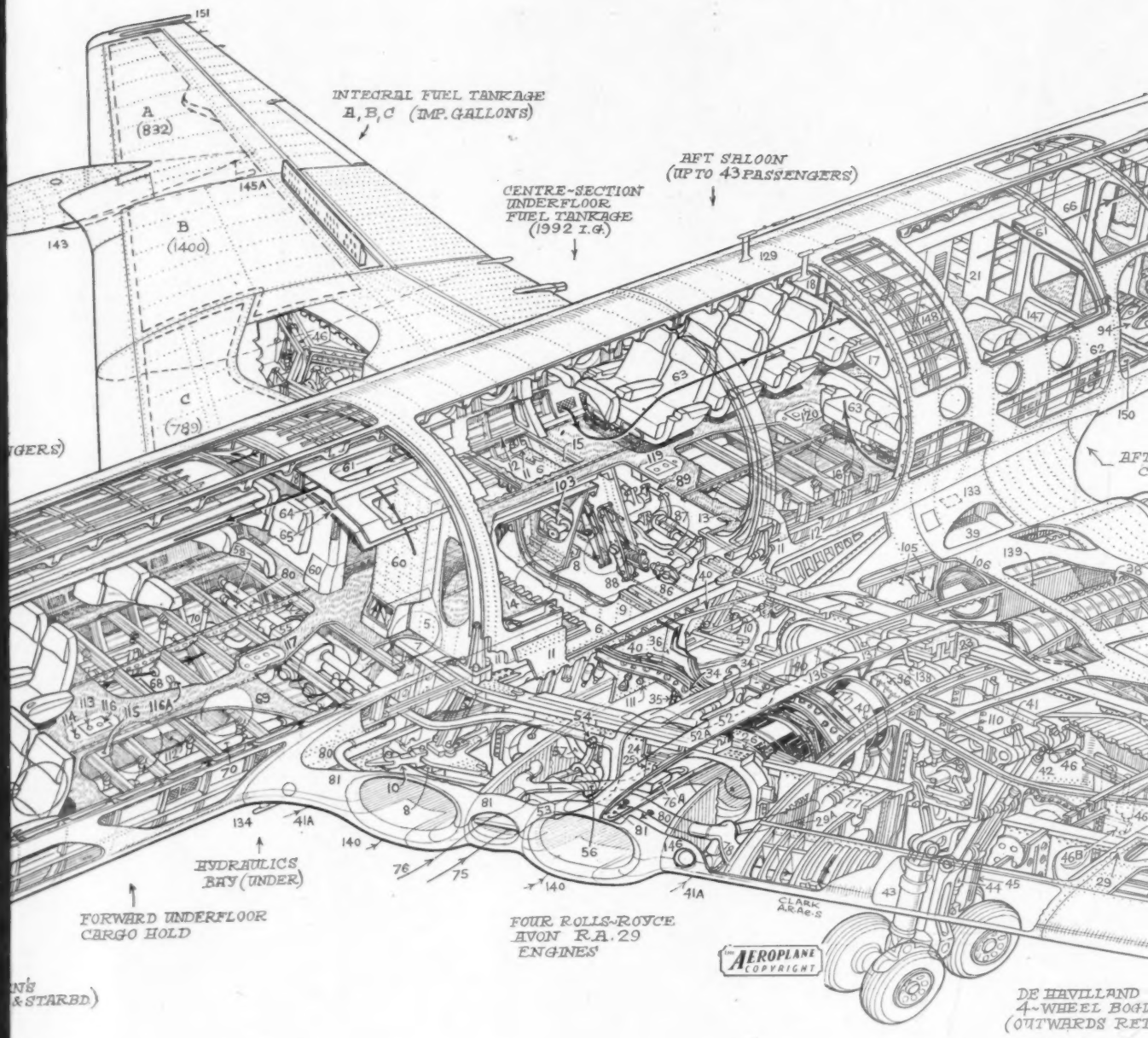


(*Key continued*)

100. See 83 again. Third rod is from rudder bars (with their feel-units to harden the movement at high speed). There is no cross-coupling to 84 but a port-side cable runs (as at 85) right back to a combined cable-compensator and servo-unit 100; thence via single rod to rudder.
101. Rudder mass balance. Aileron and elevator systems are fully duplicated.
102. Roof control in cockpit with port and starboard cable-runs 102A to the operating valves of aileron, rudder and elevator servo-units, to switch in duplicate and triplicate stand-by hydraulic supplies.
103. Flap-operating servo-unit (back of centre-section rear spar, and with cables out to flaps. There is no connection between 103 and 88 drawn next to it).
104. Hinged flaps.
105. Two split flaps (one taking
top-surface contour 106).
107. Airbrake hinge and operating
109. Flap hinge on same bracket
brake gear.

Fire Protection

110. Bottles (see near undercarriag
centre-section guard 40).
111. Two spray rings to each engi
112. Cargo-hold unit. (See fuscia
of wing.)
113. Observation window
114. Switch.
115. Smoke detector.
116. Fire-extinguisher socket.
116A. Spray nozzle.
117. Hydraulics-bay unit.
118. Electrical-equipment-bay unit
119. Aileron servo-unit-bay unit.
120. Rear-cargo-hold unit.
121. Rudder and elevator servo-un



104. Hinged flaps.
105. Two split flaps (one taking the same contour as top-surface contour 106).
107. Airbrake hinge and operating jack 108.
109. Flap hinge on same bracket as that carrying airbrake gear.

Fire Protection

110. Bottles (see near undercarriage hinge and behind centre-section guard 40).
111. Two spray rings to each engine bay.
112. Cargo-hold unit. (See fuselage floor just ahead of wing.)
113. Observation window
114. Switch.
115. Smoke detector.
116. Fire-extinguisher socket.
116A. Spray nozzle.
117. Hydraulics-bay unit.
118. Electrical-equipment-bay unit (see forward door).
119. Aileron servo-unit-bay unit.
120. Rear-cargo-hold unit.
121. Rudder and elevator servo-unit-bay unit.
122. Above-floor baggage compartment smoke detector.
123. Inertia switches (nosewheel bay).

Radio

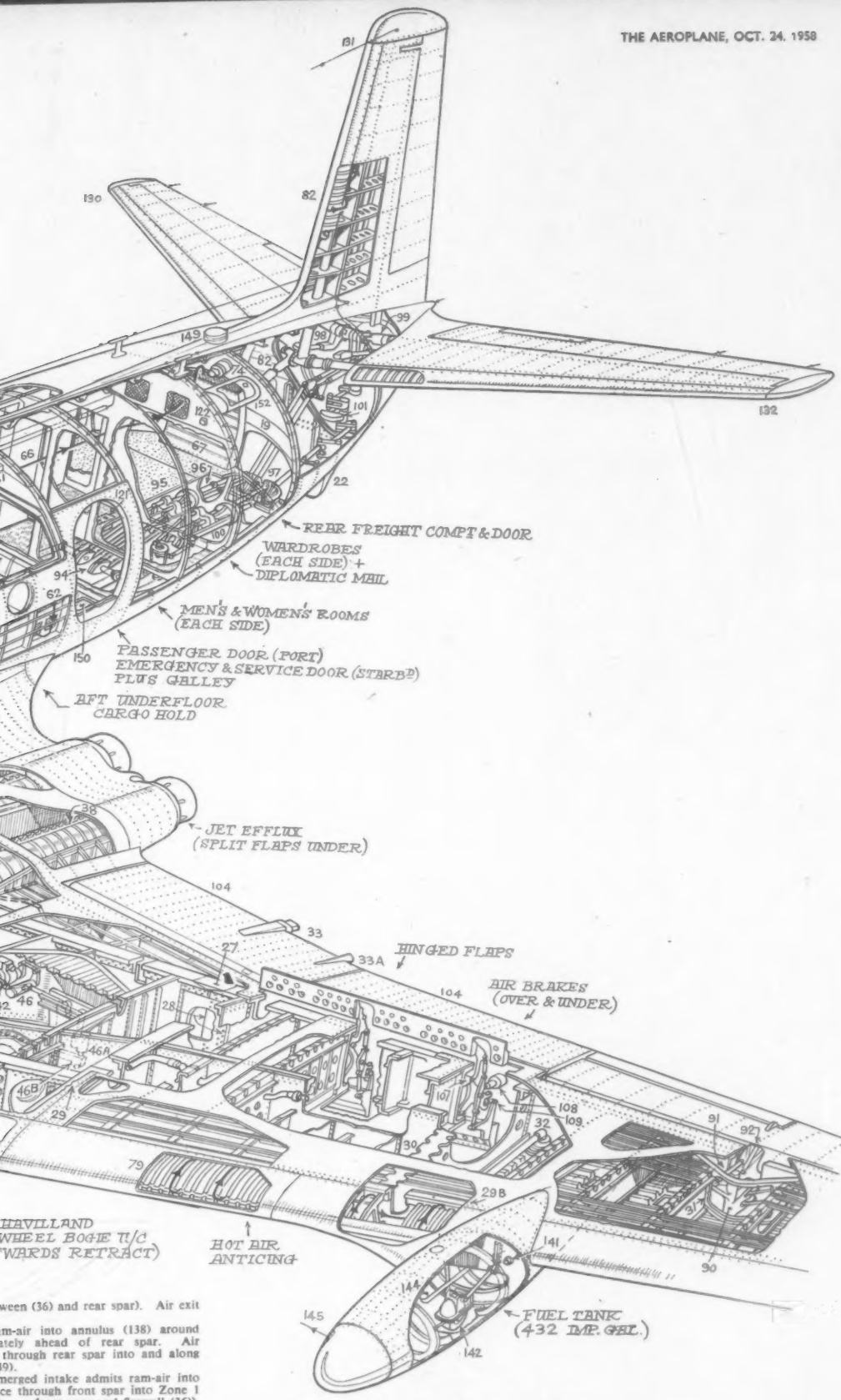
124. Search radar scanning units (in front pressure bulkhead).
125. DME receiving aerials (each side).
126. DME transmitting aerial (under, not shown).
127. ILS glide-path aerial
128. ADF loop aerial.
129. HF aerials (also used for HF stand-by and for LORAN).
130. VOR aerial.
131. VHF No. 1 fan-type aerial.
132. ILS localizer aerial.
133. DME Omni-aerial (under, not seen).
134. Two ADF sense aerials (under) and ILS marker aerial.
135. VHF No. 2 horn-type aerial.

Engine-bay Ventilation

136. Scoop puts ram-air into hollow firewall 36 from which it emerges all around engine into Zone 2 (Zone 2 lies between (36) and rea is underneath.
137. Scoop feeds ram-air into annul engine immediately ahead of passes out and through rear spa jet-pipe bay (139).
140. Underwing submerged intake ad intake bay thence through front (Zone 1 lies between front spar a Air passes out underneath in Zo
141A. (not 141A) Air intakes to coolin wing-ribs and stainless-steel heat passes out to atmosphere at rea

Miscellaneous

141. Two attachment-points (leading- rib, pod tank).
142. Underskin cutaway shows landin down landing.
143. Wipe-off fairing to wheel.
144. Tank breather and filler connecti tankage.



ween (36) and rear spar). Air exit

m-air into annulus (138) around
tely ahead of rear spar. Air
through rear spar into and along
39).

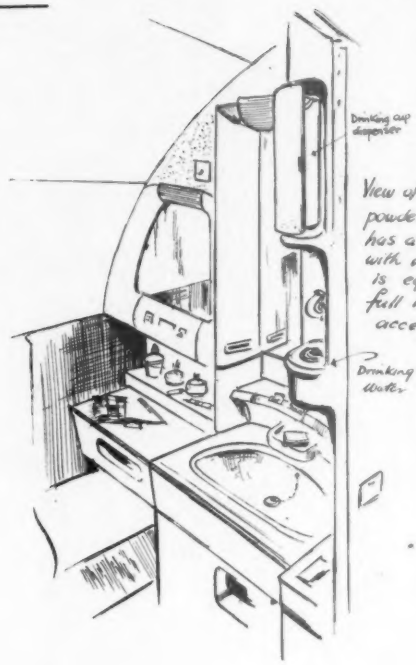
nerged intake admits ram-air into
ce through front spar into Zone 1
ween front spar and firewall (36)).
underneath in Zone 1.
intakes to cooling-spaces between
ainless-steel heat shields (40). Air
tmosphere at rear spar.

t-points (leading-edge to oblique

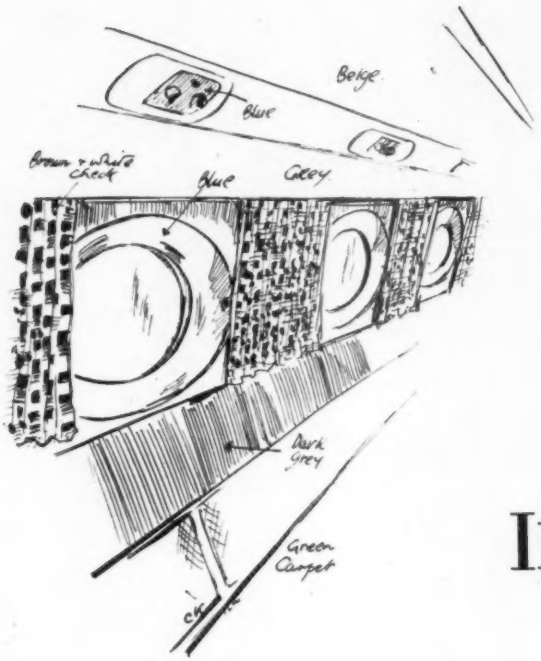
way shows landing-wheel for wing-

to wheel.
and filler connection back to wing

145. Spotlamp shines on leading-edge (for ice detection).
145A. Pod breather (underwing).
146. Landing lamp.
147. Two stewards' seats plus swing-out armrest as 3rd seat.
148. Service-trolley under cover.
149. High-intensity flasher indicator (revolving mirror lantern, lighthouse fashion).
150. Escape chute (underfloor stowage inside each door) plus hand-rope above door.
151. Fuel tankage vent.
152. Water tank (see rear freight compartment).

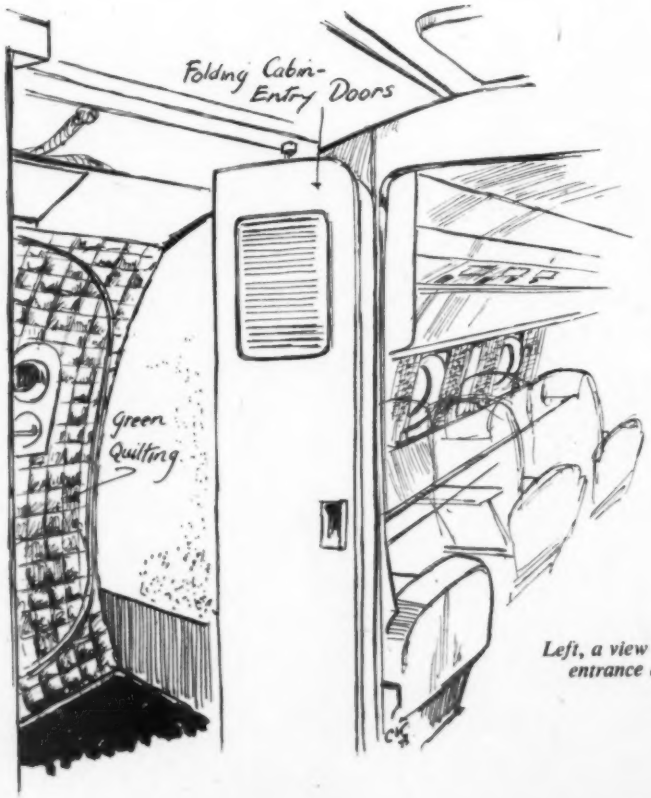


View of one of the powder rooms. Each has a dressing table with well-lit mirrors, and is equipped with a full range of toilet accessories

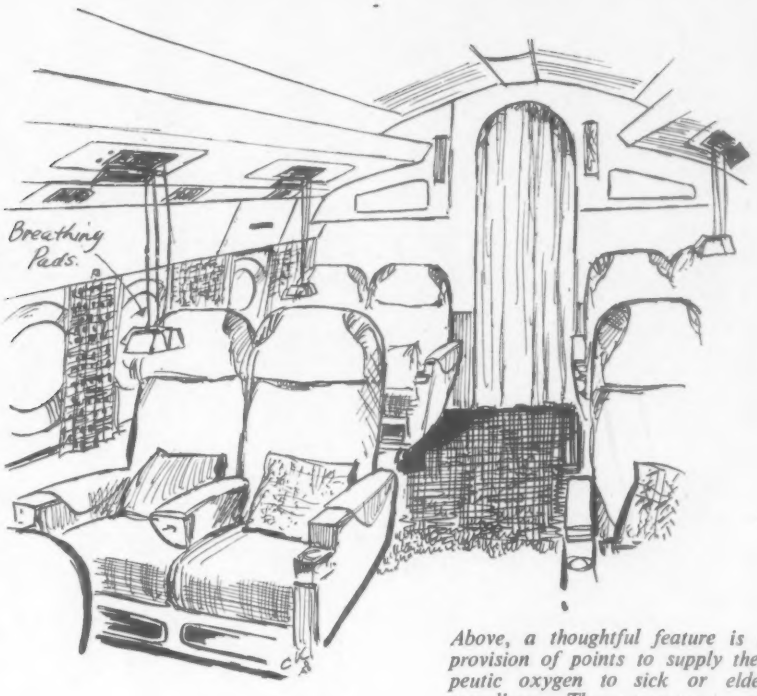


INTERIOR IMPRESSIO

***These sketches, specially drawn for THE A
King, give impressions of some of the Comet***



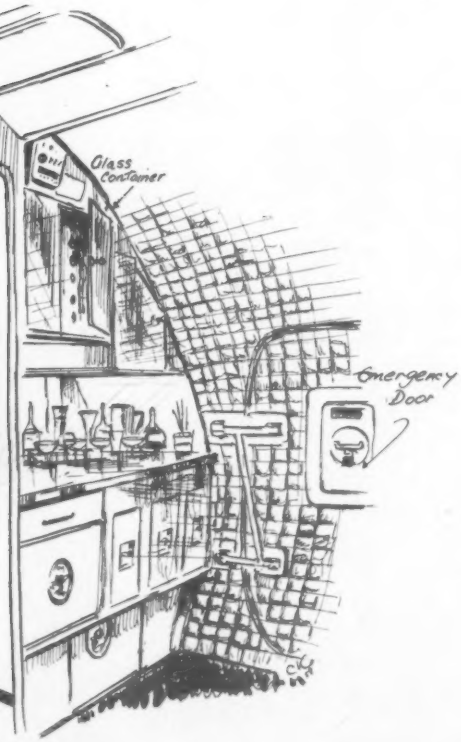
Left, a view of the passengers' entrance door and lobby.

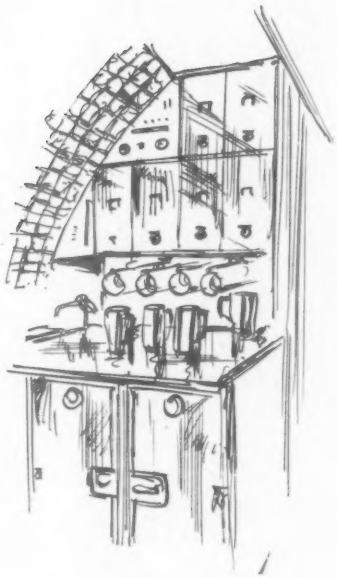


Above, a thoughtful feature is the provision of points to supply therapeutic oxygen to sick or elderly travellers. The emergency system can supply oxygen to all passengers—from the first-class arrangement up to the economy class of 81 seats.

SSIONS

r THE AEROPLANE *by Charles*
the Comet 4's "domestic" features





Above, hot drinks are dispensed from this section of the main galley. Left, in addition to the main galley the Comet 4 has this sub-pantry at the rear of the cabin.

COMET DATES AND DETAILS

Comet prototypes. Two prototypes of D.H. 106 ordered by the M.o.S., September, 1946, to Specification 22/46. Both had single main-wheel units and were otherwise to Comet 1 standard.

G-ALVG. First flew (as G-5-1) July 27, 1949. Used to test bogie main undercarriage in fixed installation, December, 1950. Made Sprite-assisted take-off trials at Hatfield, starting May 7, 1951. Tested droop-snoot leading-edge for Comet 1 and 2 December, 1952. Broken up for structural testing at R.A.E. late 1953.

G-ALZK. First flew (as G-5-2) July 27, 1950. On loan to B.O.A.C. for development flying and route proving March 22 to October 24, 1951. Used to test-fly "pinion"—tank installation for Comet 3, 1952. Broken up.

Comet 1. First production standard. Span, 115 ft.; length, 93 ft.; weight, 105,000 lb. (later, 107,000 lb.); fuel, 6,050 Imp. gal. Four 5,050-lb.s.t. Ghost 50 Mk. 1 engines. Bogie undercarriage. B.O.A.C. contract for eight (later nine) placed January 21, 1947. Normal-category C. of A. awarded January 22, 1952. Fleet details follow; all flew in regular service with B.O.A.C. from delivery until April, 1954.

G-ALYP. First production aircraft; flew January 9, 1951. Operated World's first turbojet commercial service London-Johannesburg-London, May 2-6, 1952. Destroyed off Elba January 10, 1954.

G-ALYR. Flew July 28, 1951. To R.A.E. for water-tank fatigue tests, July, 1955.

G-ALYS. Flew September 8, 1951. First Comet formally handed over to B.O.A.C., February 4, 1952. Used for prolonged jet buffet tests at R.A.E. after Comet service suspended.

G-ALYU. Flew December 31, 1951. Operated first Comet service on B.O.A.C.'s eastern route to Colombo, August 12, 1952. Eventually used for passenger-escape trials at Cardiff.

G-ALYV. Flew April 9, 1952. Broke up in extreme turbulence after take-off from Calcutta, May 2, 1953.

G-ALYW. Service with B.O.A.C. then to R.A.E.

G-ALYX. Service with B.O.A.C. Used for prolonged engine tests at Hatfield after Comet service suspended; then to R.A.E.

G-ALYY. Service with B.O.A.C. Crashed near Naples, April 8, 1954.

G-ALYZ. Delivered to B.O.A.C., September 30, 1952. Ground-stalled on take-off from Rome, October 26, 1952, and totally destroyed.

Comet 1A. Second version of the initial production series, having 5,125 lb.s.t. Ghost 50 Mk. 2, 3 or 4 engines with water injection. Fuel, 6,906 Imp. gal.; weight, 110,000 lb. (later, 115,000 lb.). Orders by C.P.A. (2) December, 1949; U.A.T. (3) May, 1951; R.C.A.F. (2) November, 1951; and Air France (3) November 21, 1951. Details follow in order of production.

CF-CUM. First Series 1A. for C.P.A., flown August 11, 1952. To B.O.A.C. as G-ANAV in autumn, 1953. To R.A.E. for special flight tests.

CF-CUN. Second for C.P.A. Ground-stalled and crashed during max. weight night take-off from Karachi, March 3, 1953, on delivery flight to Sydney, where C.P.A. had based their Pacific operations.

F-BGSA. First for U.A.T., delivered to Paris, December 17, 1952, and operated first service to Casablanca and Dakar, February 19, 1953. In service until April, 1954. Now at Le Bourget.

F-BGSB. Second for U.A.T. In service until April, 1954. Now at Le Bourget.

5301. First for No. 412 Sqn., R.C.A.F. Delivered to Ottawa, May 29, 1953. Modified to Comet 1XB standard at Chester and returned to service on September 26, 1957.

5302. Second R.C.A.F. Delivered Ottawa, June 16, 1953. As 5301.

F-BGSC. Third for U.A.T. Overshot runway at Dakar, June 25, 1953, and written off.

F-BGNX. First for Air France. Acquired by M.o.S., re-registered G-AOJT and returned to U.K., June 27, 1956. Now at R.A.E.

F-BGNY. Operated first Air France turbojet service, Paris-Rome-Beirut, August 26, 1953. Re-registered G-AOJU, modified to Comet 1XB at Chester and as B.O.A.C. crew trainer by Marshalls. Operates at 117,000 lb.

F-BGNZ. Third for Air France. At Hatfield for droop-snoot leading-edge mod., April 1954. Acquired by M.o.S. as G-APAS; modified to Comet 1XB standard at Chester; transferred to R.A.F. as XM823.

Comet 1XB. Designation of certain Comet 1As modified at D.H., Chester, following the Comet Inquiry, to permit continued operation on military duties. See 5301, 5302, F-BGNY and F-BGNZ.

Comet 2X. One M.o.S. prototype for the Comet Series 2. Actually fourth production Series-1 airframe. G-ALYT, fitted with 6,500-lb.s.t. Avon R.A.9 (Mk. 501 and, later, 502) turbojets. Dimensions as Comet 1. First flown February 16, 1952. Used for B.O.A.C. proving flights to South America, September, 1953. In 1957, temporarily fitted with thrust-reverser on one engine, and used for engine-icing trials with water-spray rig. Operates at 108,000 lb.

Comet 2. Second major production series with Avon engines and longer fuselage. Span 115 ft.; length 96 ft.; weight 120,000 lb.; fuel, 6,906 Imp. gal. Four 7,300-lb. s.t. Avon R.A.25 (Mk. 503 and Mk. 504) engines. Orders were: 12 for B.O.A.C.; three for C.P.A.; three for U.A.T.; six for Air France; three for British Commonwealth Pacific Airlines; two for Japan Air Lines; two for Linea Aeropostal Venezolana; and four for Panair do Brazil.

When work on Comet 1 and 2 was suspended in April, 1954, 22 Series 2 were in hand at Hatfield, including those already flown; three in hand at Chester and others at Belfast. Whole B.O.A.C. fleet, registered G-AMXA to G-AMXL inclusive were Hatfield production.

G-AMXA. First production Series 2, flew on August 27, 1953, with Avon 503 engines and made tropical trials, January-February, 1954. G-AMXB and G-AMXF became Comet T.2 (see below). Eight others—G-AMXG, 'XH, 'XI, 'XJ, and 'XL, plus two unregistered at Hatfield and one unregistered at Chester—became Comet C.2 (see below). G-AMXA, 'XC and 'XE became Comet 2R (see below). Two more at Hatfield and one at Chester are in long-term storage as C.2s. Two remain civil as Comet 2Es (see below). One at Hatfield was used in special pressure tests. Remaining five, in early stages of construction, were scrapped.

Comet 2E. Two Series 2, G-AMXD and G-AMXK, specially modified to have Avon R.A.29 (Mk. 524) outboard and Avon R.A.25 (Mk. 504) inboard to build up hours on the R.A.29. G-AMXD first flew as 2E, April, 1957, having previously flown as standard Series 2 with four Avon 504. In this form made tropical trials, autumn, 1955.

Comet 2R. Three Comet Series 2 transferred to R.A.F. for special duties with No. 90 Group on radar and electronic development. Numbered XK655, XK659 and XK663, they were previously G-AMXA, 'XC and 'XE, and were modified by Marshalls at Cambridge.

Comet T.2. Two Comet Series 2 modified by D.H. at Hatfield for limited-life service with R.A.F. Transport Command and used by No. 216 Sqn. as crew trainers. XK669 (first flown December 9, 1955) and XK670, previously G-AMXB and 'XF respectively. G-AMXB originally flew as second production Series 2, November 3, 1953.

Comet C.2. Eight Comet Series 2 modified for duty with No. 216 Sqn., and having heavy-duty freight floor in addition to modifications incorporated in the T.2. Avon Mk. 117/118. Numbered XK671, XK695 to XK699 and XK715-XK716.

Comet 3. Third major Comet series, originally announced autumn, 1952. Span 115 ft. Length 111 ft. 6 in. Weight 145,000 lb. Fuel, 8,308 Imp. gal. Four 9,000-lb. s.t. Avon R.A.16. Orders by B.O.A.C. (5), February 1, 1954 (replacing an option on 11); Pan American (3), October 20, 1952; and Air India (2), June, 1953. One prototype built.

G-ANLO. M.o.S. prototype for Comet Series 3. First flew, with 10,000-lb. s.t. Avon R.A.26 (Mk. 522) engines, July 19, 1954. Modified to have 10,500-lb. s.t. Avon R.A.29 (Mk. 523) engines, "q"-feel and other features of the Comet Series 4, it began new series of trials, February 25, 1957. See also Comet 3B.

Comet 3B. The Comet 3 prototype, G-ANLO, modified as prototype Series 4B with short-span wing, minus pinion tanks, and thrust reversers on the outboard engines. First flew in this form, with B.E.A. livery, on August 21, 1958.

Comet 4. Succeeded Comet 3, March, 1955, incorporating thicker skins and other refinements dictated by Comet Inquiry. Dimensionally similar to Comet 3. Weight, 152,500 lb. increasing to 156,000 lb. and, later, to 158,000 lb. 10,500-lb. s.t. Avon R.A.29 (Mk. 524) engines. Orders: B.O.A.C. (19) registered G-APDA to G-APDT inclusive (except 'PDQ); Aerolineas Argentinas (6) and East African Airways (2). Capital Airlines' order for four (July 24, 1956) since cancelled.

G-APDA. First production Comet 4, flew April 27, 1958. Used for C. of A. testing, including 100-hr. route proving. Normal-category C. of A. awarded September 30, 1958.

G-APDB. Flew August 27, 1958. Delivered to B.O.A.C. at London Airport, September 30, 1958, and used to inaugurate World's first passenger jet service across Atlantic from New York to London, October 4, 1958.

G-APDC. Flew September 23, 1958. Delivered to B.O.A.C. September, 30, and operated first service, London—New York, October 4.

G-APDE. Flew September 20, 1958. First of 14 Comet 4s in production at Chester, all for B.O.A.C.

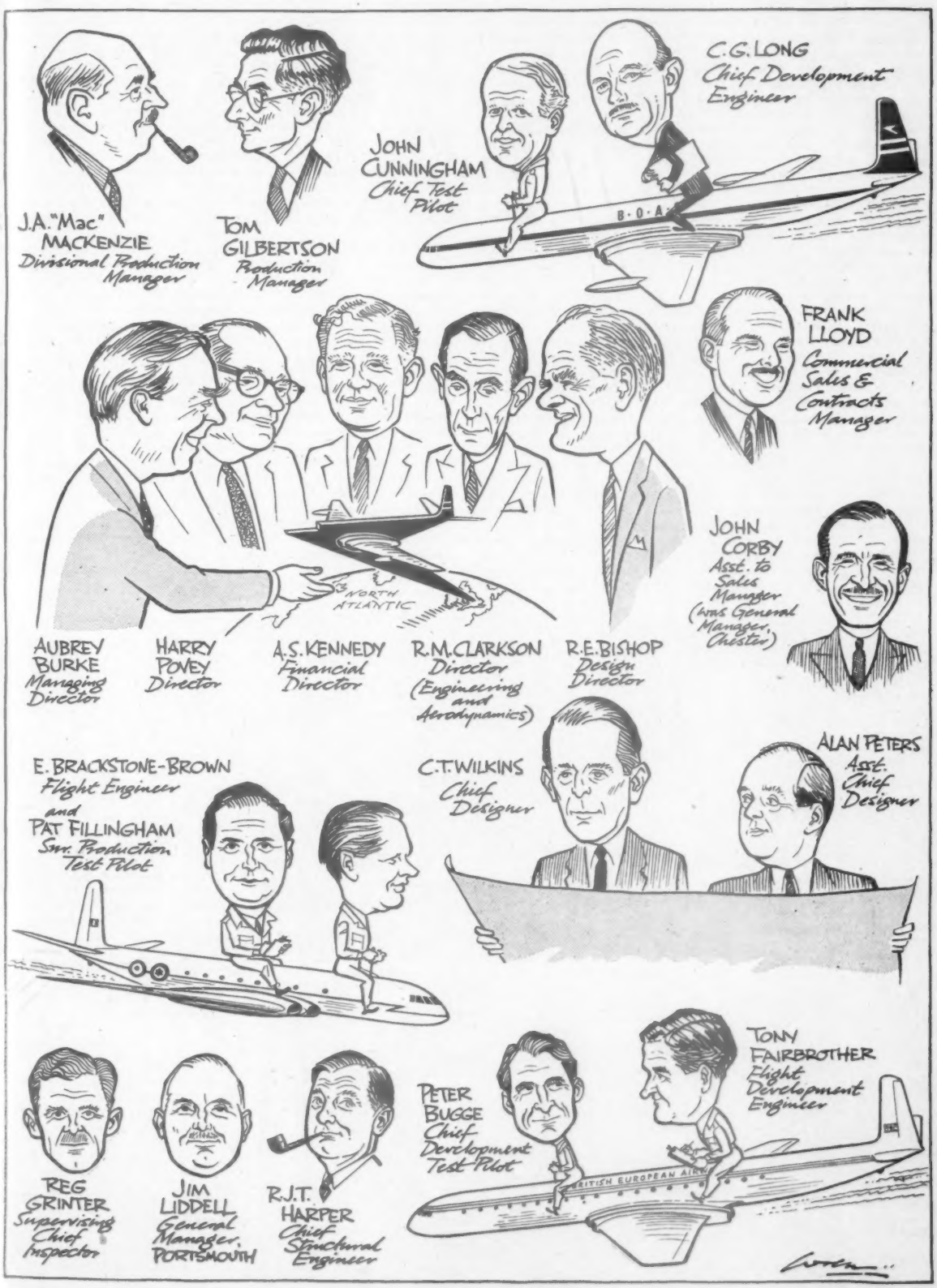
Comet 4A. Comet 4 variant for short-range operation at lower altitudes, announced in July, 1956. Span 107 ft. 9¾ in. Length 114 ft. 10 in. Fuel 8,730 Imp. gal. Weight 152,500 lb. Capital Airlines ordered 10 on July 24, 1956, along with four Comet 4s. Order cancelled in 1957.

Comet 4B. A Comet 4 variant announced in spring, 1957, with shorter span and longer fuselage, but minus pinion tanks and therefore for shorter stages than the proposed 4A. Span 108 ft. Length 118 ft. Fuel 7,890 Imp. gal. Weight 156,000 lb. Four 10,500-lb. s.t. Avon R.A.29 (Mk. 525) engines. Six ordered by B.E.A., to be registered G-APMA to G-APMF. See Comet 3B.

Comet 4C. A Comet 4 variant proposed in December, 1957, combining standard wing and fuel tankage with long fuselage of Comet 4B. Span 115 ft. Length 118 ft. Fuel 8,990 Imp. gal. Weight 156,000 lb.

B.O.A.C.'s New Comets . . . .

Comet Men at de Havillands



B.O.A.C.'s New Comets . . . .

(*Continued from page* 612)

and African routes have not changed very much since those days and DME equipment is still essential.

Nevertheless, DME is not necessarily the only means of providing the required information. Dectra/Decca can provide it where, such as on the Atlantic run, the transmissions are available, and, in certain circumstances, even weather-mapping radar can give the information. But, depending on whether there is a following wind or otherwise, the Comet 4's "straight-in" let-down is started anything up to 180 miles away from the destination and the mapping facility of the radar is not reliable beyond a range of about 100 miles.

So it can be used as a guide to, or a confirmation of, position only when there is a coastline (as at Keflavik on the westbound run and at Gander) or other definite landmark within this distance on the way towards the airport of destination. In heavy traffic areas, however, let-downs are started about 100 miles away so that the holding pattern can be entered at 20,000 ft. From this pattern the final descent is made at 3,000-4,000 ft./min. With the Comet 4, incidentally, holding is normally made on four engines unless a low-level pattern has to be maintained for long periods.

So far as the remainder of the Comet 4's navigational and communication equipment is concerned, all the essential items —such as VHF and HF, ADF, VOR and ILS—are duplicated, and this fact leads to a reliability standard which finally removes any need there might be for a specialist radio officer. During the Comet 1 operations five years ago a radio officer was an essential member of the basic flight-deck team because HF/RT facilities were not then available on the eastern runs and because his services as a radio engineer were also likely to be in demand from time to time; the two pilots and the flight engineeer were much too busy to attend to radio faults, even if they were qualified to do so.

Another item of equipment which is coming into use in other areas of the World than North America and the Pacific—and is standard in the Comet 4—is Selcal, or selective calling system, whereby the crew of a particular aircraft is alerted only when a message is intended for that aircraft, and there is thus no longer any need for the crew to listen-out continuously. Selcal ground equipment has been in use at Shannon for some time, is now available at L.A.P. and will soon be available at Gander and Keflavik.

The pattern of day-to-day Atlantic operations with the Comet, as with the Boeing 707-120, will depend on circumstances and, in the ultimate, on the way in which the air traffic control authorities manage to re-orientate and re-equip themselves to meet the new problems and the need for faster and more accurate decisions. B.O.A.C. has, it must be stressed again, a great advantage in the fact that all the Comet captains have had much more turbojet operating experience than those of other carriers have had the opportunity to obtain. Apart from the two-year period of Comet 1 service, more recent experience has been gained during the past year with the Comet 2E—which, incidentally, was flown into and out of the New York pattern without difficulty and without preferential A.T.C. treatment.

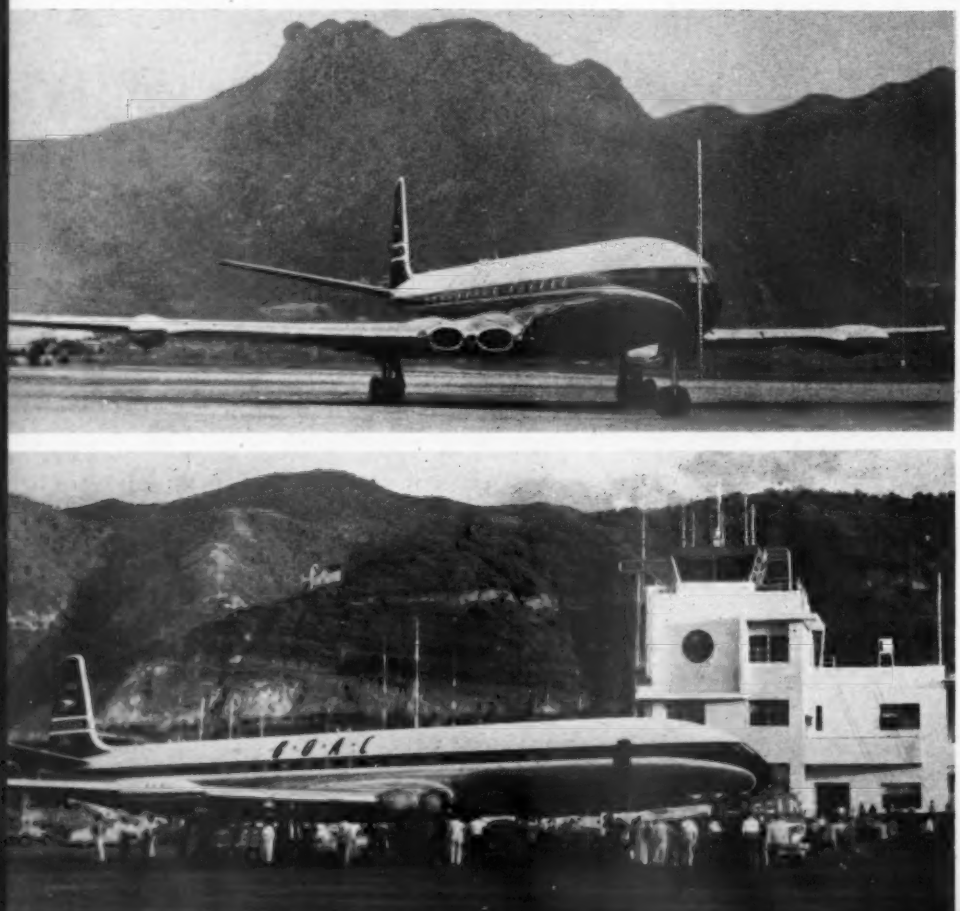
This New York traffic area is obviously going to provide a primary test for the capabilities both of controllers and turbojet flight-deck crews. Anybody who has looked at the radar displays in the Idlewild area-control centre will know that the traffic around New York is of a density which has not so far been experienced outside North America. Those who fly into and out of Idlewild know, too, how immensely busy the tower staff can be and how the whole controlling operation necessarily has to be completed on a minute-by-minute *ad hoc* basis. With the amount of traffic and the complications of the area, the work has to be done, and is done, with very great efficiency.

Nevertheless, the circumstances are such that last-second changes of flight-plan may be inevitable—and such changes are going to be liked rather less by the turbojet crews than by those of propeller aircraft. The latter can tolerate a change of plan which is made when the aircraft is lined up for take-off and which may involve, for instance, being held down to 5,000 ft. for 15 minutes or so.

For the turbojet crew such an A.T.C. change of plan might mean that there will not be an adequate reserve of fuel after a direct flight to Shannon and that a refuelling halt will have to be made at Gander. Worse still, since the turbojet will have left Idlewild with near full tanks, it will still be above its maximum landing weight over Gander and will need either to dump fuel or to cruise around for a while until the excess weight has been burned off. Luckily a turbojet has little difficulty in burning fuel quickly—though dumping or burning-off fuel are bad economics and to be avoided if possible.

As with the earlier Comets—and, since then, with turboprop aircraft—the engines are started on the apron only when a

(*Continued on page* 621)



MODERATE-SIZED AIRPORTS.—The Comet 4 on the new runway at Kai Tak, Hong Kong (above) and at Carácas Airport at Maiquetia, Venezuela. Both these airports have, by turbojet requirement standards, limited-length runways (8,340 and 7,200 ft. respectively), yet they can be used by the Comet for take-offs at near maximum weight. From Carácas Airport, which also has very high ambient temperatures, the Comet flew the 2,140 st. miles to New York during its recent tour of the Americas.

B.O.A.C.'s New Comets . . . .

(*Continued from page* 620)

through clearance, to taxi and to take off, has been obtained. This procedure has usually involved a period of waiting for the passengers after they have boarded the aircraft—and, at busy airports, this period may sometimes be quite a long one for the turbojets. Means will be found of ensuring the equanimity and comparative happiness of the passengers and it will be better for them to suffer a little minor discomfort in the aircraft than to be shepherded back into the terminal and then rushed over to the aircraft—which, by the time the harassed passengers have got into their seats and the doors have been locked, might have missed its brief period of clearance. This is one of the little difficulties which can only be smoothed out with practice, experience and the best use of the aircraft's public address system.

The facts of the earlier Comet era and of the use of the 2Es for engine-development and training has meant that crews who were already experienced have been able to convert quickly during the comparatively short time in which Comet 4s have so far been available to B.O.A.C. This training has, during the period prior to the start of the services, been completed, for the most part, at the R.A.E. aerodrome at Thurleigh, near Bedford, where there is a very adequate runway, all the navigation aids and little traffic. Comets have been refuelled at L.A.P., in the morning and during the midday break, and been flown to Bedford, where ILS approaches, overshoots and other exercises have been completed until the weight was down to the maximum for landing—after which there would still be enough fuel (15,000-20,000 kg.) for 3-4 hours of flying before returning to L.A.P.

Airways and approach pattern practice and training—especially necessary for crews who have not previously been flying in the New York area—has been completed on the Stratocruiser simulator, which was designed for this purpose. It has now been fitted with the Smiths Flight System and has had its electronic and other devices adjusted to offer a performance similar to that of the Comet 4—including rates of descent of up to 4,000 ft./min. It is a pity that the performance of real aircraft cannot be modified quite so comparatively easily. The real Comet simulator, by Redifon, should be ready for use in April next year.—H.A.T.

Impressions of an Atlantic Operation

IT would obviously be pointless to attempt to base a considered article about the Comet's performance as a North Atlantic transport on the impressions obtained during one training and proving flight. So the overall problems and techniques involved in the operation have been separately discussed on the previous pages—and these first-hand comments take second place—with necessary reservations, and, perhaps with some apologies to those on the turbojet's flight deck (who really know what it is all about) from one whose practical experience has been limited to that with steam aeroplanes.

The passenger in the Comet 4 on a westbound Atlantic crossing will, if he takes an intelligent interest in the operation and is lucky enough to be able to talk to a member of the flight-deck crew, arrive at New York International Airport with a number of new ideas and impressions. For me, five impressions remain as the most important:—The angle of the initial climb; the way in which it may pay fuel dividends to follow a track which is far from anything resembling a direct Great Circle track; the fact that, with a nine-hour-plus endurance, a Comet 4 operation is not quite, for the flight deck crew, the rat-race it used to be with the Comet 1; that if you are to arrive, you must fly the Comet to a strict drill in relation to its limiting Mach number for different conditions; and that a public address system is much more important than it has been in the past.

The Comet's take-off and climb in service, even at near maximum weight, are nothing if not impressive—though it will be advisable for the steep angle to be explained to new passengers before the aircraft leaves the apron. Obviously there is no positive need to make a habit of this somewhat spectacular departure—but it is the method designed to reduce noise disturbance in the neighbourhood of airports and will presumably be applied, as a matter of course, to all departures.

At a speed 10 knots less than V2 the nosewheel is lifted and the Comet is rocked into a steep take-off attitude which is maintained (at V2 plus 15 knots) to a minimum height of 1,200 ft. There the revolutions are brought back from 8,000 to 7,350 and the speed is allowed to build up to that for the most efficient climb to initial operating height. To the passenger who remembers the technique with the Comet 1—for which the nosewheel was allowed to brush the runway until V2 was reached and the aircraft, after being lifted off, was then held down to reach the best climb speed—the behaviour of the new Comet is exhilarating. From a normally long runway and climbing at about 3,000 ft./min. the Comet is at 1,000 ft. over or soon after crossing the reciprocal threshold.

On our particular proving flight a landing was made at Keflavik, Iceland, for training and familiarization reasons, rather than at the point which will be the more usual for westbound refuelling, Gander, Newfoundland. Upper winds were strongly adverse on the direct track from there to New York, so we flew well to the north, crossing Greenland and turning on a more southerly heading only after reaching Fort Chimo, which is in the northern part of Quebec Province, in the latitude of Hudson Bay and way north of Goose Bay, Labrador. Winds in latitudes south of our track were of the order of 120-140 knots and blowing from W.S.W.

Typical of the present traffic situation over the North Atlantic were the instructions we received while on the way from Fort Chimo to overhead Montreal. We had cruise-climbed up to 41,000 ft. as weight was burnt, but were told that the altitudes between 35,000 ft. and 45,000 ft. were blocked for the use of military traffic—so we descended to a much less efficient cruising altitude. Things were, however, going fairly well; we had something like nine hours of fuel aboard when we left Keflavik and Goose, Montreal and Washington were all open if the New York weather turned sour. Only Boston, with poor local visibility, was closed as an alternate.

No doubt hard thinking and planning were going on up on the flight deck, but there seemed, by comparison with conditions on the four-hour Comet 1 sectors, to be plenty of time in which to make and re-make plans and an ample number of alternates if the fuel situation appeared to demand their use. In fact, we spent some 20 minutes or so in the New York traffic pattern before making a final approach into Idlewild. Nevertheless, the situation for the turbojet is always likely to be a harassing one if the best height cannot be used.

The Comet is amply powered and therefore Mach-limited at high altitudes, so it must, for best results, be flown to a strict Mach number/airspeed/power régime according to aircraft weight and temperature if performance is not to be sacrificed.

Because even a four-hour flight in a turbojet transport can become a little monotonous for the passenger, the best use should be made of the public address system, with plenty of information provided during the cruise or cruise-climb. The system is valuable, too, as already mentioned, for explaining the take-off procedure and, when necessary, the often inevitable delay after the passengers have come aboard and while the crew is awaiting through clearance from apron to take-off.

It can also be used to tell the passengers in the rear compartment that there will be a sudden increase of noise as the power is reduced for descent and the engine bleed valves are opened. This rear compartment, incidentally, is no more than average in terms of noise-level, which is equivalent to that at the rear cabin of a Stratocruiser or DC-7C—though without the vibrations experienced in propeller-driven aircraft. There may be disappointment among passengers in this compartment if its characteristics are over-sold—and particularly if, during the flight, they move up through the bulkhead into the area forward of the leading-edge, which is a near-perfect environment.

Various little points were learnt during this flight. Thrust reversers, for instance, are to be fitted to the seventh Comet for B.O.A.C. and the earlier aircraft will then be retrospectively modified. The earlier aircraft, too, have the emergency oxygen equipment and masks under the the seat, to be used on instructions from the flight or cabin crew. All aircraft will shortly have an automatic oxygen-supply system installed; if the cabin pressure falls to the equivalent of that at 14,000 ft. masks will drop from the overhead racks and a supply of oxygen will be automatically turned on. One might suggest that this feature could be demonstrated, with a single mask unit, when lifebelt drill is being explained before take-off.

The need for a "go-no-go" take-off indicator is not quite so pronounced for an aircraft which is as amply powered as the Comet 4, but it is still a useful thing for the flight-deck of any turbojet aircraft. Such devices are designed to tell the pilots whether or not the acceleration is developing satisfactorily so that a take-off can be abandoned, if necessary, in good time.

The Comet has four instruments which provide much of the information required. These are the power-loss meters on the central engine-instrument panel. They show, by a comparison of pressures in the powerplants, that the power is being maintained and provide, at a glance, information which could otherwise be obtained only by comparing the r.p.m., jet-pipe temperatures and fuel-flow figures.—H.A.T.

B.O.A.C.'s New Comets . . . .

The Commercial Avon

FOUR Rolls-Royce Avon R.A.29 10,500-lb. thrust axial-compressor turbojets are the powerplant of the de Havilland Comet 4, and a most comprehensive programme of testing has preceded the entry into service of this engine. An important outcome of this is the 1,000-hr. initial overhaul period for the R.A.29 which has been granted by the Air Registration Board.

Two Comet 2E aeroplanes were each fitted with two R.A.29 engines in the outboard positions and two 7,300-lb. thrust R.A.9 turbojets in the inboard locations. These aircraft (G-AMXD, owned by the M.o.S., and G-AMXK, owned by B.O.A.C.) were operated by the Comet Flight, B.O.A.C., under Capt. T. B. Stoney, from September, 1957, until May, 1958, on daily scheduled flights between London and Beirut—an aircraft utilization of 11 hr. a day.

Eight engines were involved in this programme, four installed and four spares, but endurance flying was concentrated on six engines in order to put up high individual totals of running time. A total of 7,000 hr. was obtained, with one premature removal which was a result of excessive slipper-pad wear and consequent seizure of the fuel pump on one engine. The engine concerned was removed as a precautionary measure. This resulted in a temporary restriction of fuel-pump authorized life until the cause of excessive wear had been discovered. An improved slipper pad has since been introduced, which should bring pump life to the same as for the engine.

At intervals of 250, 500, 750, and 1,000 hr. the engines were stripped and examined by the A.R.B. Two engines, Nos. 35002 and 35007, were removed at 997 and 1,030 hr. respectively. The condition after stripping was found to be excellent. Both engines were later run on a test-bed and had a performance within the acceptance limits for new engines. The flame tubes of engine No. 35002 had already completed 250 hr. service before starting on the 1,000-hr. test. After it was finished, they were built into another engine to be examined after a further 500-hr. of operation.

Following this test programme the Comet Flight was asked to carry out further flying with the cruising r.p.m. of the R.A.29 engines raised from the normal 7,100 to 7,400 and throttling them back for 5 min. every 2 hr. to reproduce the rapidly changing temperatures experienced on short-haul operations, as will be experienced by the Comet 4B.

At all times it has been the policy to test R.A.29s with as much related Comet airframe in the test-bed as possible to ensure correlation of results with flight testing. For this reason a Comet engine air intake was obtained from de Havillands for use with all type-testing performed by Rolls-Royce. Similarly a "fire-tunnel" at Hucknall was used to check-out two R.A.29 engines built into a stub-wing; various causes of fire were reproduced and the effectiveness of the fire-protection system was proved.

Noise-reducer units were fitted to the Comet 3, aerodynamic prototype of the Comet 4, and were first shown publicly at the 1957 S.B.A.C. Show. This year the Comet 3 had, in addition to noise-reducers on all four engines, thrust-reverser units on the two outer engines.

Comet 4s now in service with B.O.A.C. are fitted with noise-reducers. Testing of the thrust-reversers is almost complete and production of them has started at Rolls-Royce. The first units will be ready in April of next year. B.O.A.C. have no immediate need of these, but their Comet 4s have provision for them and thrust-reversers will be fitted by B.O.A.C. when operating in the eastern hemisphere. B.E.A. will use thrust-reversers as standard equipment in the Comet 4B.

The Comet Installation

Engines buried in the wing roots are unique to the Comet as a jet airliner. The four Avons are in pairs on each side of the fuselage, located between front and rear spars of the wing.

Independent fuel feed is given to each engine, this being a C.A.A. requirement but not yet specified by A.R.B. All fuel cocks are manually controlled, the low-pressure cocks being mounted above the bottom booms of the front spar for maximum protection.

Fuel heaters are provided. It is possible for the aircraft tanks to receive "loose" water from bowser refuelling and, unless fuel heaters were installed, this might well freeze-up the fuel filters and stop the supply to the engines.

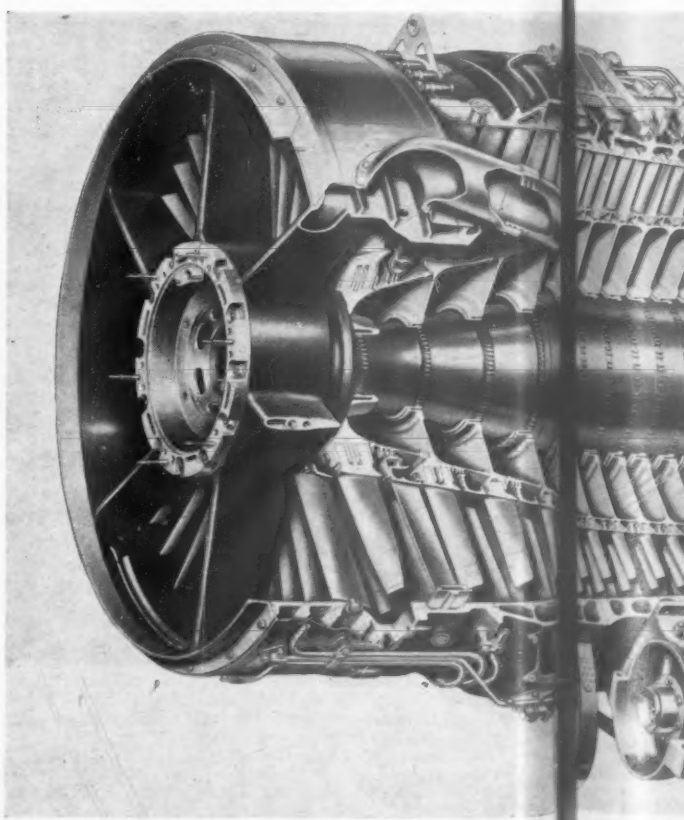
Most of the Comet's fuel is contained by integral wing tanks, but a certain amount is in bag tanks in the wing centre section. These latter are of Marston Excelsior Marlite type and de Havillands have had unusually good results with them.

The Comet's fuel tanks are pressurized only for jettisoning of fuel, when engine compressor air is reduced to 3 p.s.i. and used for dumping the fuel. There are, of course, a number of safeguards against over-pressurizing the tanks. These include a duplicated pressure-reducing valve, a blow-off valve set at ¼ p.s.i. lower pressure in the tanks themselves, and duplicated vent valves. All the main fuel tanks are connected side-to-side so that all pressure-relief in the system is available across the whole aircraft fuel system. An entirely new type of fuel booster pump has been developed by S.P.E. for the Comet.

An interesting detail is the fuel outlet design which neatly avoids the possibility of static electricity igniting fuel when it is dumped overboard. The fuel vent pipe has a rubber extension tube fitted to it and the joint covered by a metal "flair" or collar. It has been demonstrated on test that static electricity discharges from the "flair" while fuel is safely dumped some distance away from the end of the conductive rubber tube.

Tests have also been made to prove that dumped fuel is vented clear of the airframe in the event of over-filling. All engine leakages are collected so that no leaks are dropped to the ground.

ROLLS-ROYCE AVON R.A.29.—Principal differences of the civil R.A.29 from earlier military engines are the use of a 16-stage compressor and a three-stage turbine. The Rolls-Royce 200 Series Avon family of engines was described, with a cutaway drawing of the Avon R.A.28, in our issue for October 11, 1957.



Compared with the R.A.25 installation of the Comet 2, the R.A.29s of the Comet 4 have better general protection from fire hazard and improved engine-bay ventilation sealing. The combustion zone of each engine is now encased in titanium. Titanium is also used for firewalls, bulkheads, drain system and engine-mounting forgings. About 400 lb. is saved on each aircraft by the use of titanium.

Fire-detector circuits of the Graviner Firewire re-setting type are used and the engine jet pipes are lagged to reduce heat-transfer to the surrounding structure. Two-shot fire-extinguishing is provided in the engine fire zones. The whole leading edge of the wing containing electrical and hydraulic runs is protected by a single-shot system. In the centre section a two-shot system looks after fuel, hydraulic and electrical lines.

Beneath each pair of engines is a crash switch which closes the high-pressure fuel cocks in the event of a belly landing and operates the fire-extinguishers. A time-delay switch in this circuit disconnects the aircraft batteries after 3 sec.

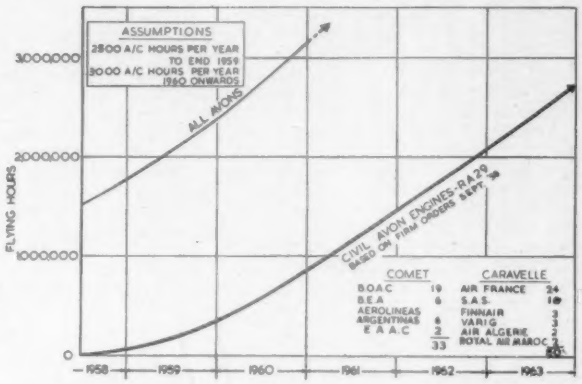
Design Development of the R.A.29

In developing the Avon turbojet for commercial operation Rolls-Royce had several clear aims—improved specific fuel-consumption, unquestionable reliability and long component life. Design of the civil engine, the R.A.29, began at the end of 1954 and the engine first ran in March, 1956.

Apart from a general work-over of all mechanical design of the military R.A.28 engine, the R.A.29 has important differences in aerodynamic design. A zero-stage has been added to the axial compressor, which now has 16 stages, and a three-stage turbine replaces the two-stage design of the earlier engines. The new turbine also has improved sealing for higher efficiency.

The anti-icing standard of the R.A.29 is improved, A.R.B. requirements being far more stringent than those of the C.A.A. The efficacy of the system has been found in test flying with an Avro Ashton test-bed and the D.H. Comet 2s. The original Comet 2 was fitted with an R.A.29 with a spray-grid mounted in front of its air intake to produce heavy icing conditions. The Avon R.A.29 shares with the Bristol Proteus the distinction of being one of the two civil engines fully tested in respect of icing. The Comet 4 has made trials in the tropics and the R.A.29 has proved to be insensitive to dry ice.

Generally, it has been found that possible causes of engine trouble after long service can best be indicated by overload and

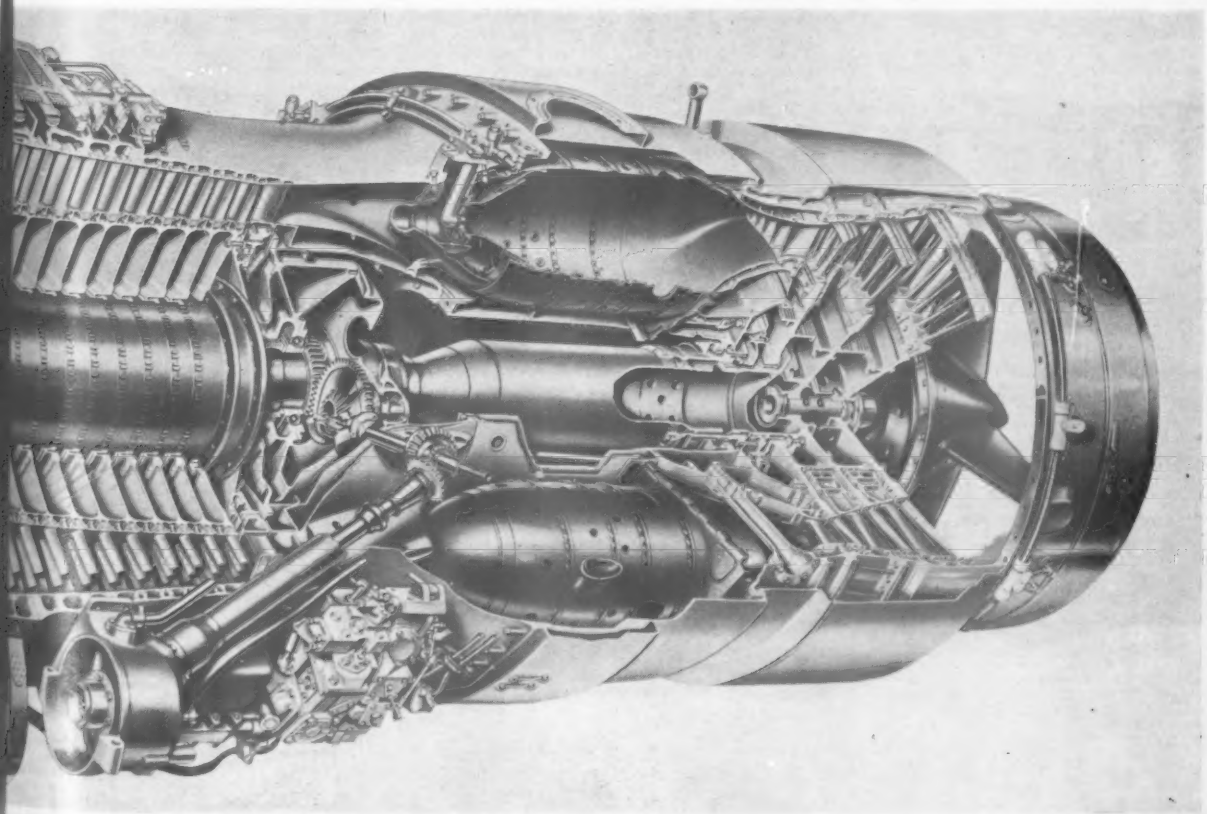


AVONS IN SERVICE.—This graph shows the anticipated build-up of engine flying hours with civil and military Rolls-Royce Avon turbojet engines.

cyclic testing. Short bursts of running in exaggerated operating conditions are more useful in this respect than long periods of steady operation on a test-bed. Tests have included engine handling, the R.A.29 being particularly good in this respect with no tendency to surge on rapid opening-up from idling speed. Other tests have included cold-starting.

Use of a 16-stage compressor has raised the air mass flow of the R.A.29 to 173 lb./sec. which, by approximating with the ratios of the known specific fuel consumptions of the R.A.29 (0.775 lb./lb./hr.) and the R.A.28 (0.86 lb./lb./hr.) means that the air mass flow has been increased by about 11%. (Although the s.f.c. for the R.A.29 is from the brochure, an analysis of the production R.A.29s so far delivered gives an average fuel consumption of 0.76 lb./lb./hr.) Pressure-ratio of the R.A.29 is 9.27 : 1 compared with the estimated ratio of 7.8 : 1 for the R.A.28 (THE AEROPLANE, February 21).

Flame tubes, of which there are eight in a common annular casing, have been improved to obtain a good temperature-traverse with even distribution of temperature at the turbine inlet. This prolongs the life of the turbine by avoiding



B.O.A.C.'s New Comets . . . .

variations of temperature. Turbine inlet temperature is 1,068°K. and the turbine efficiency is 91%. Static thrust at take-off is 10,500 lb. compared with 10,000 lb. for the R.A.28.

There are two R.A.29 versions for the two Comet types. The Mk. 524 for the Comet 4 has a certain amount of titanium to save about 40 lb. weight, while the Mk. 525 for the short-haul Comet 4B does not incorporate so much of this material.

Materials may thus vary slightly, according to customer. Compressor rotor blades are of aluminium alloy in stages 0 to 8 and titanium in stages 9 to 15. Stage 0 stators are hollow steel because of the need to provide passages for anti-icing hot air. Stator stages 1 to 4 are aluminium alloy, stages 5 to 8 are in steel and stages 9 to 15 are of titanium or stainless steel. The turbine cooling air manifold can also be of either titanium or steel alloy.

Later developments of the R.A.29. are the R.A.29/3 of 11,700-lb. thrust and the R.A.29/5 of 13,300-lb. thrust. This increased power is obtained in the case of the R.A.29/3 by use of a two-position exhaust nozzle. A similar nozzle is also used on the R.A.29/5, but it is evident that this engine must have a greatly increased mass flow which can possibly be obtained by adding an extra stage to the compressor and probably by use of air-cooled turbine blades to allow the engine to run hotter without increasing the s.f.c.

The nozzle on the R.A.29/3 (which engine is destined for the Sud-Aviation Caravelle as the Avon Mk. 527) is "closed" to reduce the exhaust exit area by about 5% at take-off when the throttle is fully open. Its operation is automatic by a simple linkage to the throttle.

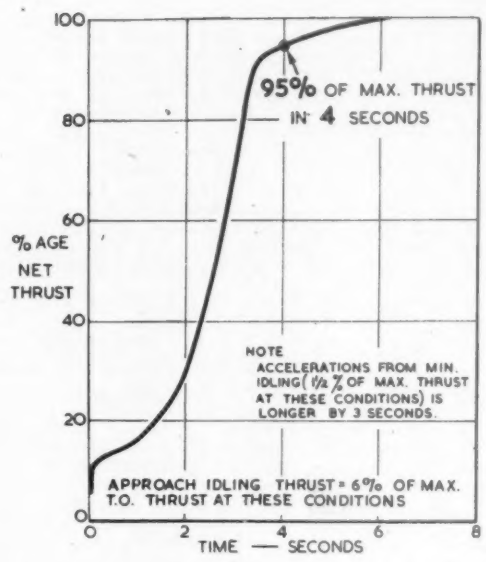
It consists of a small flap lying flush with the noise-reducer contours which is lowered into the efflux at full throttle. This has the effect of speeding up the exhaust efflux because of the reduced nozzle-area.

Air mass flow through the engine remains the same, but the pressure ratio at take-off is increased to 9.63 : 1 from 9.27 : 1 and the flame temperature at the turbine inlet is increased to 1,160°K. from 1,068°K. This increases the thrust from 10,500 lb. to 11,700 lb. at take-off. Nimonic 100 turbine blades are used in the R.A.29/3.

There is no requirement for the R.A.29/3 or R.A.29/5 in the Comet at present, but the availability of such engines is doubtless welcome, particularly when a larger engine could not be installed because of airframe dimensional limitations.

There is also a three-position nozzle available and this is used on the Avon R.A.29/5 Mk. 530 for the developed Caravelle. The nozzle is "closed" at take-off, at an intermediate setting for climb and "open" for cruising flight.

Serviceability is a most important aspect of commercial engine operation and Rolls-Royce philosophy for transport engines is that they should be able to keep running as long as possible "as a going concern." This concept produces engines with a long overhaul life with no stripping in the field for replacement of vital parts.

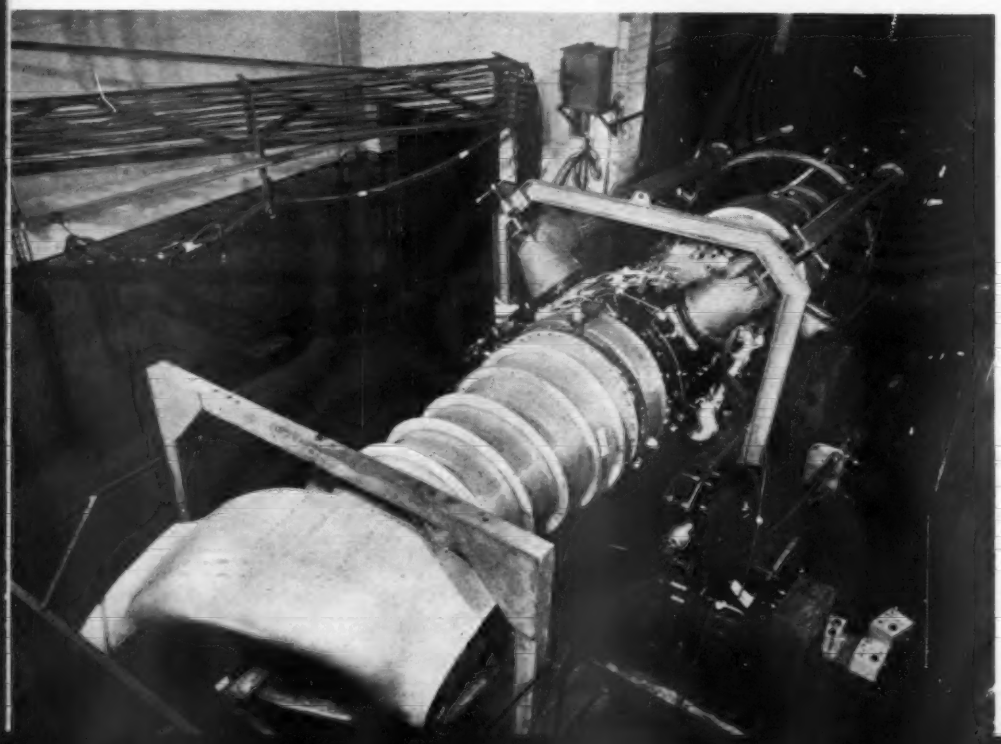

100
80
60
40
20
0
% AGE NET THRUST
95% OF MAX. THRUST IN 4 SECONDS
NOTE ACCELERATIONS FROM MIN. IDLING (½% OF MAX. THRUST AT THESE CONDITIONS) IS LONGER BY 3 SECONDS.
APPROACH IDLING THRUST = 6% OF MAX. T.O. THRUST AT THESE CONDITIONS
0 2 4 6 8
TIME — SECONDS

QUICK RESULTS.—This shows acceleration of the R.A.29 from approach idling to governed speed. The flight conditions were an airspeed of 125 knots at 650-ft. altitude with an ambient temperature of 19.5°C. (67°F.).

That long initial component life has been achieved by the R.A.29 was shown by the condition of components when two Avons were stripped for inspection after 1,000 hr. running, the result being that the Air Registration Board granted a 1,000-hr. overhaul period before the Comet 4 entered service with B.O.A.C. The same period is expected to apply to the Caravelle.

It is now expected that this period will be progressively extended until a 2,000-hr. period is permitted within two years of examining the first engines to reach 1,000 hr. in service.

Civil Avons can be overhauled either at Derby or by the operators themselves with suitable help from Rolls-Royce. In the case of some overseas operators it may be geographically uneconomic to send the engines back to England. Service project engineers are available to follow up the engines as they enter service and give any necessary help and liaison with the Derby establishment.—D.G.

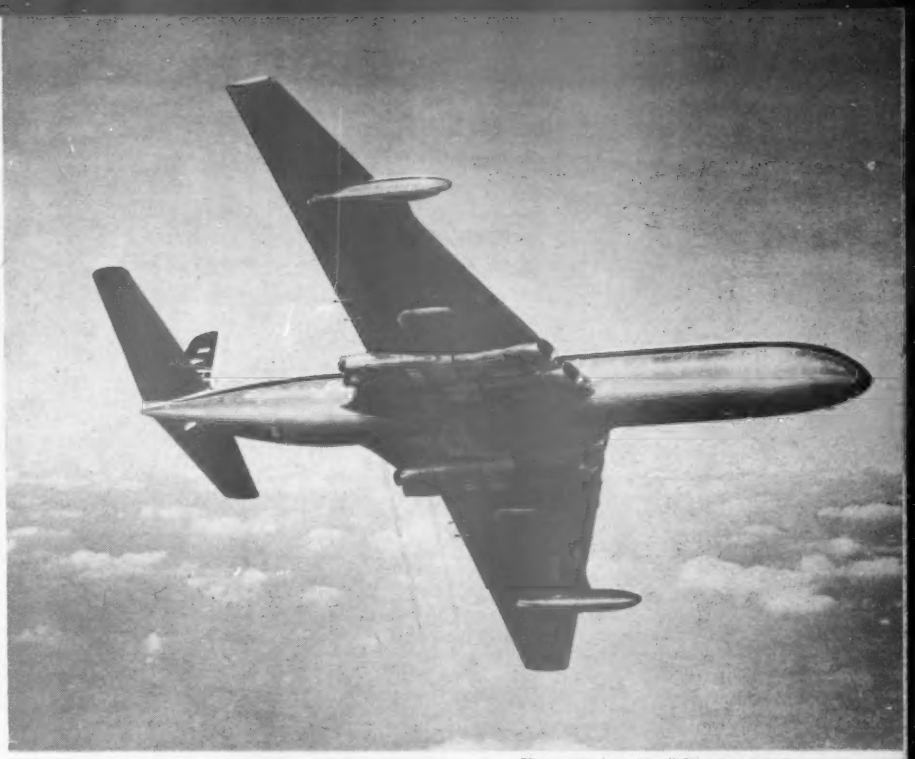


RIG REALISM.—For test-bed running of the Avon R.A.29 turbojet, Rolls-Royce obtained a Comet 4 air intake and ducting from de Havillands. Fire tests were made at Hucknall with a Comet stub wing and engine bay mounted in a "fire tunnel."

B.O.A.C.'s

New Comets . . . .

The Comet's Development Background



Photograph copyright "The Aeroplane"

OVERWHELMING SUCCESS, a sudden descent into tragedy and a steady climb back to success—this summarizes the nine years of the de Havilland Comet story since the prototype first flew in 1949. In 1952 the Comet 1 made history as the first jet airliner to enter service; the return of the Comet in 1958 has been marked by another milestone—the first jet services over the Atlantic. Its interrupted career has undoubtedly given the Comet many advantages over its American rivals, understandably so because it is approaching the end of its development life while they are on the threshold of theirs.

Extensively developed and with thousands of hours of operating experience behind it, the Comet has entered North Atlantic service as a new airliner more thoroughly proven than any before it. Not for nothing has Mr. Aubrey F. Burke, de Havilland deputy chairman and managing director, said that the Comet is the most-tested airliner ever. It is this aspect of the Comet which will be high-lighted in the following account, which surveys Comet history and covers the major alterations and developments in its structure, systems and aerodynamics since the first prototype flew.

Flight development of the Comet was rapid; very few modifications were necessary between its first flight in 1949 and its entry into service on B.O.A.C.'s South African service on May 2, 1952, less than three years later. The aircraft was an immediate success, and made money for the Corporation from the start, despite its high break-even load factor of 72%. During its first month in service the load factor achieved was 89% and over the first year of Comet operations the load factor averaged 80%.

Meanwhile de Havillands were working on developed versions of the Comet. First was the Comet 1A, developed for Canadian Pacific Airlines, Union Aéromaritime de Transport and Air France. This version of the Comet 1 had increased tankage, an all-up weight which, at 115,000 lb., was 10,000 lb. up on that of the Comet 1, and a passenger load increased from 36 to 44.

A stretched version of the Comet, the Comet 2, was developed to extend the aircraft's range and payload. Engined with Rolls-Royce Avons, the Comet 2 was some 3 ft. longer than the Comet 1. Its all-up weight was 120,000 lb. and its longest practical stage length some 2,200 miles. Its first flight was on August 27, 1953.

With Comets in successful airline service, orders for the aircraft flowed in; 49 had been ordered by August, 1952. In October that year news was given of the Comet 3, which had a greater capacity and range than the Comet 2. This Comet was to have an all-up weight of 145,000 lb., passenger capacity of 58 to 78, and a maximum stage range of about 2,700 miles, about 60% more than that of the Comet 1. Orders for it were received from B.O.A.C., Pan American and Air India.

In March, 1953, a Comet 1A crashed on take-off at Karachi. It failed to leave the ground, apparently because of its extreme nose-up attitude which put the wing into a semi-stalled state. This accident, together with a similar one which had occurred at Rome in October, 1952, focused attention on the ground stall and hastened the development of the drooped leading edge fitted to later Comets. After the Rome accident the existing instructions on take-off technique had been elaborated to guard against this type of accident.

Successful and profitable operation of Comets was continued by B.O.A.C. until January 10, 1954, when the Elba accident occurred. Comets were withdrawn from service, but were reintroduced 10 weeks later after a range of precautionary modifications had been introduced. But soon afterwards, in April, 1954, another Comet crashed off Naples.

These were the accidents which led to the remarkable R.A.E. investigations and to a public inquiry. The report of the court was issued in February, 1955; it stated that the disasters were caused by structural failure following pressure-cabin fatigue. No negligence was involved; the aircraft had been correctly designed in the light of the knowledge then available.

As soon as this report was issued B.O.A.C. signified its faith in the Comet by ordering 19 Comet 4s, which was the next stage in the development of the Comet line. The Comet 3 first flew on July 19, 1954; it has been progressively modified since as the development aircraft for the Comet 4. Aerodynamically identical to the Comet 4, the Comet 3 was fitted with Avon R.A.29 engines in February, 1957, and has been used for 80% of the certification work in connection with the Comet 4.

After the accident-inquiry report was issued Comet 2s then in production were structually modified; they entered service with R.A.F. Transport Command in June, 1956, and since then have flown more than 14,500 hr. in routine operations eastwards to Australia and westwards across the Atlantic and the Pacific to Christmas Island. The R.C.A.F.'s two Ghost-engined Comet 1As were modified and have returned to service.

Enter the Comet 4

The first Comet 4 flew on April 27 this year and received its airworthiness certificate little more than five months later, on September 29. The first transatlantic services with Comet 4s were flown on October 4. This rapid entry into service, ahead of Pan American's Boeing 707s, has been helped by B.O.A.C. experience with Comet 2Es. These aircraft, fitted with Avon R.A.29 engines in their outer nacelles, have been intensively flown by B.O.A.C. since September, 1957, to gain operating experience with the engines of the Comet 4.

Comet 4s are also on order for Aerolineas Argentinas, who will have six, and East African Airways, who will have two. British European Airways has ordered six Comet 4Bs; this version of the Comet 4 has a short-span wing and a longer fuselage. It will cruise faster than the Comet 4 and at lower altitude, carrying up to 100 passengers over stage distances between 300 and 1,500 miles.

Another version of the Comet 4 is the 4C, which will combine the passenger capacity of the 4B with the Mk. 4 wing. None of these has yet been ordered.

Although the Comet 1 was revolutionary in its basic concept, every effort was made to design it in line with current engineering practice. Nevertheless, it was inevitable that the Comet 1 should break new ground in many respects. For instance, it

Thorough water-tank testing has been a feature of Comet 4 development. Here, in wintry conditions, loads are applied to a Comet 4 wing. The fuselage to which it is attached is immersed in a water tank so that it can be repeatedly pressurized.

B.O.A.C.'s New Comets . . . .

was the first airliner with powered flying controls, the first with a bogie undercarriage and the first in which the turbojet engine compressor was tapped to provide air for the cabin pressurization and air-conditioning systems. But, in many respects, the systems of the Comet 1 were simpler than those of contemporary piston-engined airliners, and their serviceability proved better. An outstanding feature of the Comet was the simplicity of its cockpit layout; many of the controls essential for a piston-engined airliner were not needed on the Comet.

In the structural design of the Comet 1 de Havillands relied on well-established methods, and a series of tests was made because of the high differential pressure to which the cabin was subjected. The cabin was designed primarily for static strength to take an ultimate pressure of 2½P (where P was the working pressure) and a proof pressure of 2P. These design strengths were higher than required at that time by both British and international airworthiness requirements, which called for the cabin to withstand a design pressure of 2P and a proof pressure of 1½P. De Havilland choice of 2P proof pressure was based on expert opinion that a cabin which would survive undamaged a test to twice its working pressure would not fail in service because of fatigue. Subsequent tests on a complete Comet 1 fuselage showed that the static design strength had been achieved.

During the early development of the Comet 1 the fatigue strength of its cabin was reconsidered, and repeated loading tests were made on the forward section of the cabin. By September, 1953, this specimen had withstood 18,000 applications of P in addition to some 30 earlier applications of pressures between P and 2P. This test ended in a fatigue failure, but the specimen had withstood so many repeated pressurized cycles that, in conjunction with other tests, it was considered to have proved the safety of the Comet 1 cabin with an ample margin.

It is thus clear that every precaution then considered necessary had been taken to check the fatigue strength of the Comet 1 cabin.

Perhaps the major aerodynamic development after the Comet entered service was the drooped extension to the wing leading edge. This was under development for later marks of Comet to lower the stalling speed and decrease the landing run. Early in 1953 a series of tests showed that the stalling speed at ground level in the take-off attitude was several knots higher than the airborne stalling speed in the same attitude. To avoid this ground stall on take-off an extended and drooped leading edge was installed retrospectively on all Comet 2s. With this modification it was found impossible to stall the aircraft on the ground, and take-offs could be made at full weight with the tail bumper dragging along the runway.

This modification might have been expected to affect the Comet's cruising performance adversely. In fact, it made a negligible difference to the cruising drag. Test flights showed that the drag-rise speed with the modified wing was deferred, but that the slope of the drag-rise curve was steeper.

Following the Elba accident Comets were temporarily withdrawn from service and a range of modifications introduced to cover possible reasons for the accident; at that stage engine fire was considered the most likely cause. Modifications and investigations covered the possibility of control-surface flutter, primary structural failure, malfunctioning of the power controls, structural fatigue of the wing and of the pressure cabin at the windows and engine fire. Many of these precautionary modifications have been built into the Comet 4.

R.A.E. Investigation

After a second Comet crashed off Naples the aircraft was withdrawn from service and the thorough R.A.E. investigation began to find the reason for the disasters. Comet development was at a standstill until the report of the official inquiry was issued.

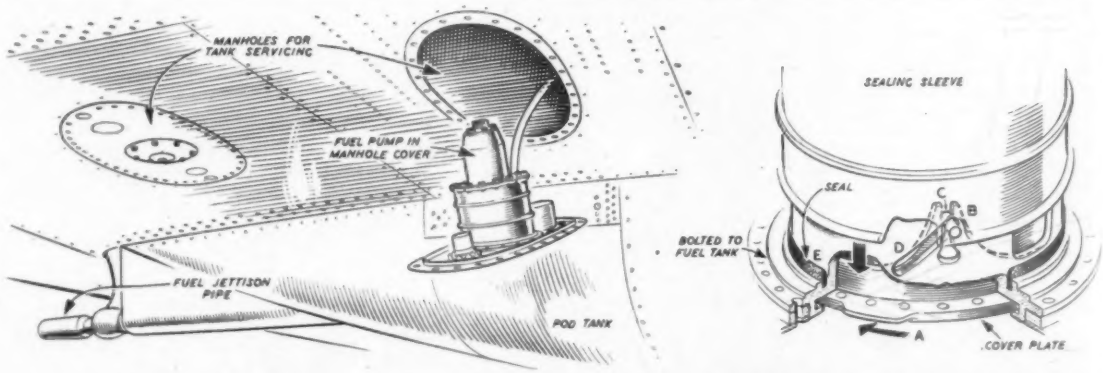
The official report of the inquiry, which blamed pressure-cabin fatigue, included a de Havilland statement on the future action proposed in Comet development. Measures would be taken in conjunction with the A.R.B. to deal with the fatigue problem. Thicker-gauge materials would be used for the pressure cabin and windows, and cut-outs would be redesigned so that local stress concentrations at rivets, bolt holes or manufacturing cracks would not lead to fatigue difficulties.

The wing structure would be redesigned in fatigue-prone areas to reduce the stress level. The fuel system would be modified to prevent fuel venting during the take-off and to prevent any possibility of structural damage during refuelling.

Another change was to be in control characteristics; it was proposed to reduce the break-out force required for initiating movement of the control column below the 18-20 lb. necessary on the Comet 1.

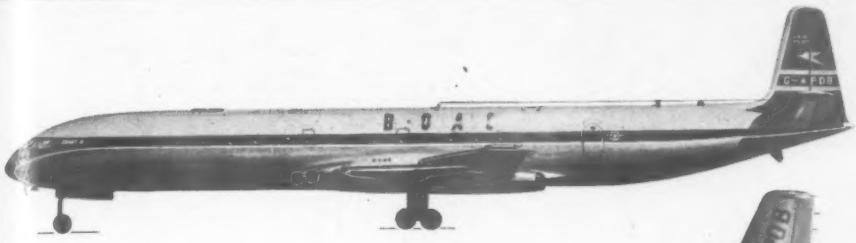
Another change which affected the structure was to be the toeing-out of the engine jetpipe to avoid pressure-wave buffeting on the fuselage structure.

These changes formed the basis of the structural design of the Comet 4. The basic policy adopted has been to establish a safe life, but fail-safe features have also been incorporated in the design. Stress levels have been kept to a low value so that



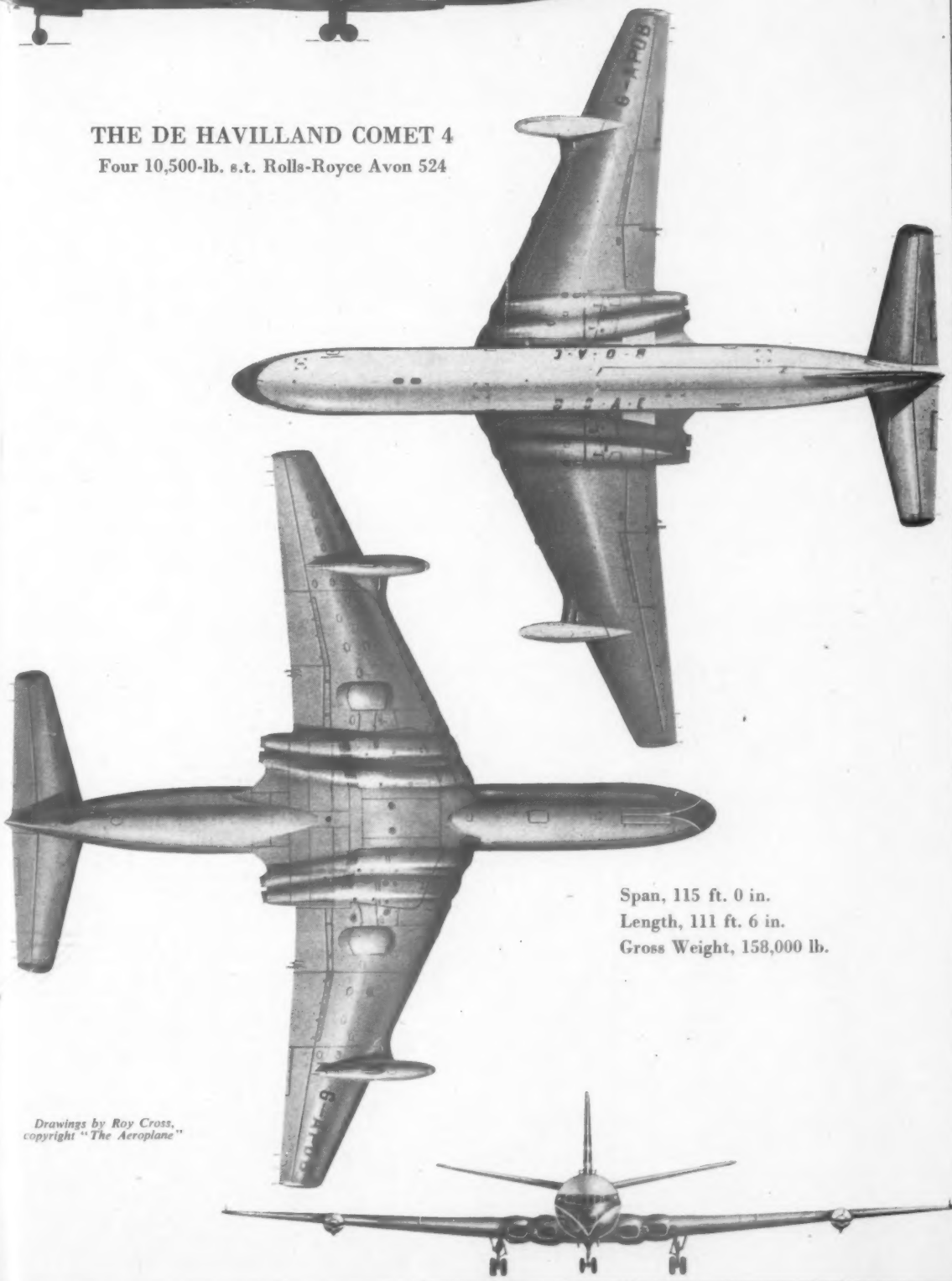
Fuel pumps are installed in the tank-inspection manhole covers. The right-hand view shows how a pump can be withdrawn for servicing without emptying its fuel tank. The fixing bolts are undone and cover plate A is rotated. Fork B, which is attached to the cover plate, guides the spigoted sleeve C down slot D onto a seal E, thus sealing off the fuel in the tank.

Drawings by Roy Cross, copyright "The Aeroplane".



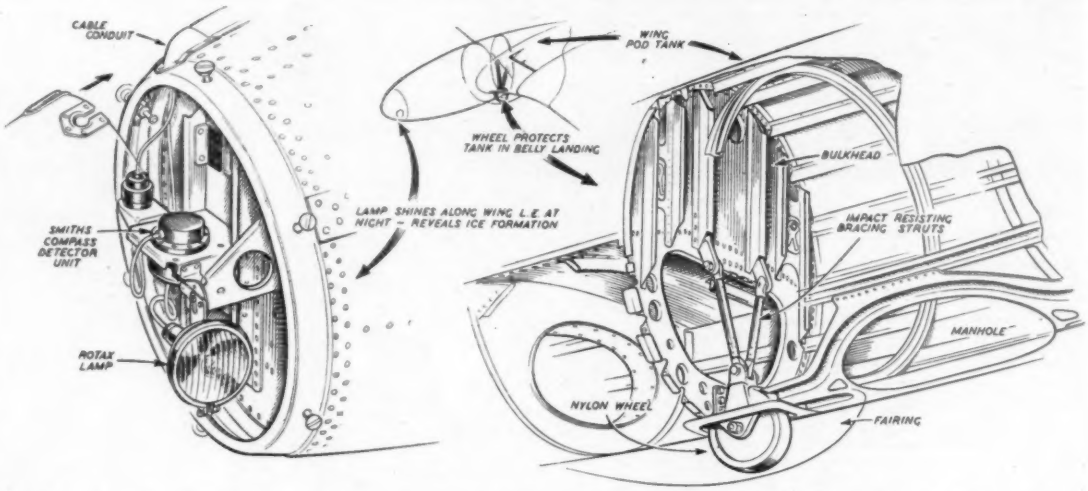
THE DE HAVILLAND COMET 4

Four 10,500-lb. s.t. Rolls-Royce Avon 524



Span, 115 ft. 0 in.
Length, 111 ft. 6 in.
Gross Weight, 158,000 lb.

Drawings by Roy Cross, copyright "The Aeroplane"

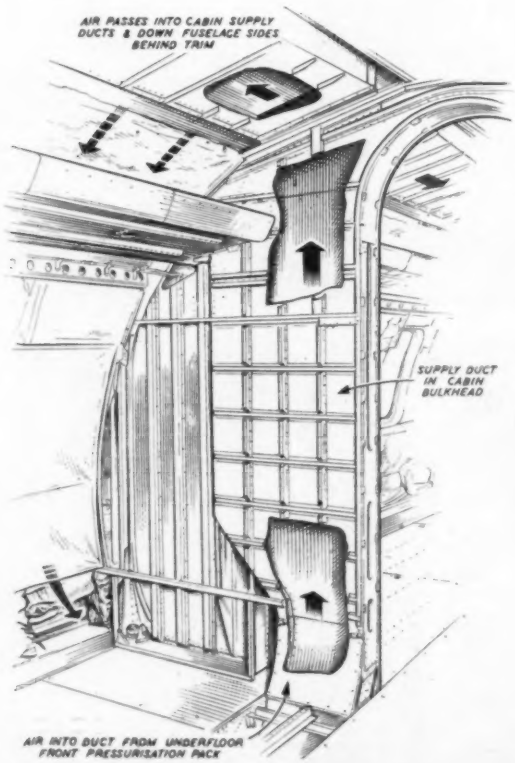


Features of the pinion tank installation on the Comet 4 wing are shown in this drawing. The wheel beneath the tank is intended to protect it in the event of a belly landing.

B.O.A.C.'s New Comets . . . .

cracks are unlikely to develop in service, and if they do they will spread only very slowly. The fuselage skin has been increased to a minimum thickness of 19 s.w.g. compared with 22 s.w.g. on the Comet 1, and as a result the working stress is only 22% of the ultimate. Doubler plates have been bonded on at fuselage cutouts.

The fatigue properties of the wing have been greatly improved by producing wing tension members and skins in copper-bearing alloy rather than the higher-strength zinc-bearing alloy originally used.


AIR PASSES INTO CABIN SUPPLY DUCTS & DOWN FUSELAGE SIDES BEHIND TRIM
SUPPLY DUCT IN CABIN BULKHEAD
AIR INTO DUCT FROM UNDERFLOOR FRONT PRESSURISATION PACK

This Comet cabin bulkhead acts as a channel for cabin air.

Hundreds of fatigue specimens have been tested in the development programme, which has progressed from tests on fuselage-skin lap joints to complete portions of the fuselage and finally a complete fuselage. The aim has been to design for a safe life of at least 30,000 hr., equivalent to 10 years of operation at 3,000 hr. per annum, during which time the aircraft will have flown some 15 million miles. Assuming a flight duration of 3 hr. this means that the fuselage will be pressurized 10,000 times.

Fatigue tests have not been confined to the pressure cabin; wing-spar components and complete wings and tailplanes have also been tested.

The test programme for the fuselage was designed to demonstrate that no cracks would occur in the specimens before 60,000 reversals, equivalent to 180,000 hr. of flying, and that any cracks occurring later would not extend seriously before another 60,000 cabin-pressure reversals. These tests were made to six times the operating life of 30,000 hr. to allow for any scatter in fatigue life. Water-tank tests were made to prove that the structure bettered these limits; certain tests were made with wing loads applied to the specimen. The centre portion of the fuselage with the wing centre section was subjected to 120,000 pressurizations and 2,880,000 wing gusts, equivalent to 360,000 flying hours, without any major structural failure occurring.

Many tests were made with wing spar joints and skin-joint specimens, as well as complete wing spars and sections of the wing structure. Although adoption of copper-bearing alloy for tension members involved a weight penalty, fatigue life was greatly increased. Safe fatigue lives for the main spar booms have been shown by full-size tests to exceed 80,000 hr., some specimens reaching very high lives.

Systems and Services

The flying-control system of the Comet 4 is fully duplicated mechanically and triplicated hydraulically. There is spring-feel on all flying-control circuits and dynamic-pressure (q) feel on the elevator control only. The high control break-out forces which were criticized on the Comet 1 have been reduced.

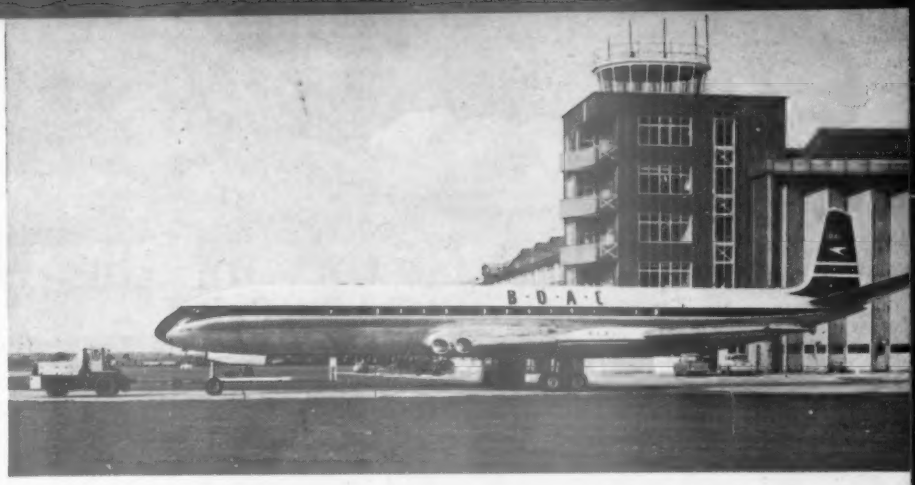
There are two gear-ratios on the elevator control; the pilot selects the change-over from the coarse to the fine control at 170 to 200 knots I.A.S. There is an automatic trim control which applies a nose-up trim change at M=0.78 indicated to counteract the nose-down trim change that the aircraft experiences at this Mach number. A warning horn sounds at M=0.77 indicated. Stall warning is given by a stick-shaker at about 10 knots above the stall.

The wing flaps of the Comet 4 are of greater area than those on the Comet 1; for landing they can be lowered to 80° compared with 60° on the earlier aircraft. This increases both the lift and the drag on landing; the stalling speed of the Comet 4 in its landing configuration is only 96 knots I.A.S. at 116,000 lb. A yaw damper has been incorporated in the rudder-circuit; this has helped make it possible for the fin and rudder size of the aircraft to remain unchanged on the Comet 4 despite its longer fuselage.

Electric power for Comet services is generated as AC and

(*Continued on page* 629)

B.O.A.C.'s New Comets . . . .



A B.O.A.C. Comet 4 is towed past the control tower at de Havilland's Hatfield aerodrome.

(*Continued from page* 628)

rectified to DC; alternator capacity has been increased from 4 x 250 to 4 x 350 amps. to cope with the greater power requirements of the Comet 4. Electric and hydraulic equipment is housed in separate under-floor bays separated by the main cargo compartment to avoid explosion risk; in the earlier Comet this equipment was in the same bay. Any electrical equipment installed in the airframe which is likely to come into contact with hydraulic fluid has been explosion tested.

The cabin pressurization system can be fed by air tapped from all four engines; air from two engines is normally used and the other two engines act as stand-by sources. Most of the pressurization equipment is supplied by Normalair; there is a self-contained pressurization pack at the rear keel of the aircraft. A stand-by pack is in the forward keel. Control of cabin pressure is automatic, cabin altitude being governed by aircraft altitude. All that the aircrew need to do is to select on an airport altitude selector the height at which pressure control is to begin or end. The installation weighs only 47 lb. compared with 93 lb. for the Comet 2.

Thermal de-icing is used for the leading edges of the wing, tail and engine intakes. Control cabin windows are demisted by Triplex electrically heated gold-film glass; only the windscreen panels immediately in front of each pilot are continuously de-iced.

All fuel tanks are integral except in the centre section, where bag tanks are used. Engines are normally fed independently. Fuel tank vents are at the wing trailing edge. The blow-off valves of the underwing pressure-refuelling system have been redesigned to avoid over-pressurizing the tanks during refuelling.

Improvements have been made in the engine installation as explained elsewhere in this issue.

Extremely thorough systems testing has been a feature of Comet 4 development. Tests have been made with a full-scale flying-control circuit and a hydraulic test rig representative of the Comet 4 system. Similar tests have been made of the electric, air-conditioning and fuel systems. Results of tests with these rigs no doubt played an important part in the rapid airworthiness certification of the Comet 4. Following functional tests with the rigs and the simulation of various failures, the rigs have been engaged on endurance tests.

This thorough background of testing, both of systems and structure, combined with thousands of hours of flight experience, gives the Comet 4 an unprecedented development background as it enters service over the North Atlantic.—J.R.C.

COMET 4 SUPPLIERS

Equipment

Airscrew Co. and Jicwood, Ltd.; Air Service Training, Ltd.; Automotive Products Co., Ltd.; Avica Equipment, Ltd.; Avimo, Ltd.; Barnet Instruments, Ltd.; Belling and Lee, Ltd.; British Electric Resistance Co., Ltd.; N.S.F., Ltd.; British Oxygen Aro Equipment, Ltd.; British Ropes, Ltd.; The British Thomson-Houston Co., Ltd.; Camerer Cuss and Co.; Cannon Electric, Ltd.; Chelton (Electrostatics), Ltd.; E. K. Cole, Ltd.

The Decca Navigator Co., Ltd.; de Havilland Propellers, Ltd.; Dowty Nucleonics, Ltd.; Dufaylite Developments, Ltd.; Dunlop Rubber Co., Ltd.; Eastern Aero Electrical Services, Ltd.; Films and Equipments, Ltd.; Flight Refuelling, Ltd.; The General Electric Co., Ltd.; Graviner Manufacturing Co., Ltd.; Hellermann, Ltd.; Hendry Relays, Ltd.; Honeywell Controls, Ltd.; Hymatic Engineering Co., Ltd.; Inferation, Ltd.; The Walter Kidde Co., Ltd.

Lancefield Aircraft Components, Ltd.; Joseph Lucas, Ltd.; Marconi's Wireless Telegraph Co., Ltd.; Marston Excelsior, Ltd.; Mechanism, Ltd.; Metalastik, Ltd.; R. W. Munro, Ltd.; Murphy Radio, Ltd.; Negretti and Zambra, Ltd.; Normalair, Ltd.; Palmer Aero Products, Ltd.; Peto and Radford; Pilkington Bros., Ltd.; The Plessey Co., Ltd.; R. B. Pullin and Co., Ltd.; The Pyrene Co., Ltd.; Pyrotenax, Ltd.

Redifon, Ltd.; R.F.D. Co., Ltd.; Rist's Wires and Cables, Ltd.; Rolls-Royce, Ltd.; Rotax, Ltd.; Rotol, Ltd.; Sangamo Weston, Ltd.; Saunders Valve Co., Ltd.; S.P.E. Co., Ltd.; Siebe Gorman and Co., Ltd.; Simmonds Aerocessories, Ltd.; Smiths Aircraft Instruments, Ltd.; Stanley Electric, Ltd.; Static Condenser Co., Ltd.

Teddington Aircraft Controls, Ltd.; Teleflex Products, Ltd.; Thermal Control Co., Ltd.; Thermotank, Ltd.; Thorn Electrical Industries, Ltd.; Titanine, Ltd.; Triplex Safety Glass Co., Ltd.; Trix Electrical Co., Ltd.; Turner and Savage, Ltd.; Ultra Electric, Ltd.; Venner, Ltd.; Vickers-Armstrongs (Aircraft), Ltd.; Walters Electrical Manufacturing Co., Ltd.

Finished Parts

E. S. Aston and Co., Ltd.; B. Attewell and Sons, Ltd.; Aviation Developments, Ltd.; Bakelite, Ltd.; Bells Asbestos and Engineering, Ltd.; The Birmingham Guild, Ltd.; British Insulated Callender's Cables, Ltd.; The Bushing Co., Ltd.; H. Comoy and Co., Ltd.; Connolly Bros. (Curriers), Ltd.; Cope and Timmins (London) (1911), Ltd.; Crane Packing, Ltd.; Dart Spring Co., Ltd.; Thomas De La Rue and Co., Ltd. (Plastics Divn.); Dowty Seals, Ltd.; Edinburgh Weavers, Ltd.

T. F. Firth and Sons, Ltd.; Hall and Hall, Ltd.; Hertfordshire Rubber Co., Ltd.; High Tension Wires, Ltd.; Imperial Chemical Industries, Ltd.; Insulation Equipment, Ltd.; William Jones, Clifton and Co., Ltd.; Kautex, Ltd.; Latex Upholstery, Ltd.; Lion Spring Co.; Midland Aeroquipment, Ltd.; Pianoforte Supplies, Ltd.; Renold Chains, Ltd.; J. W. Roberts.

Geo. Salter and Co., Ltd.; Sorbo, Ltd.; Tenaplas, Ltd.; United Spring Co.; J. Williamson and Son, Ltd.

Raw Materials

Accles and Pollock, Ltd.; The British Aluminium Co., Ltd.; Brown Davies; Cambrian Castings, Ltd.; English Steel Corporation, Ltd.; The Firth-Derihon Stampings, Ltd.; Thos. Firth and John Brown, Ltd.; High Duty Alloys, Ltd.; The Hughes-Johnson Stampings, Ltd.

Imperial Chemical Industries, Ltd. (Metals Divn.); E. and E. Kaye, Ltd.; Kent Alloys, Ltd.; H. J. Maybrey and Co., Ltd.; B. O. Morris, Ltd.; Northern Aluminium Co., Ltd.; Reynolds T. I. Aluminium, Ltd.; Reynolds Tube Co., Ltd.; Sterling Metals, Ltd.; J. Stone and Co. (Charlton) Ltd.

Sub-contractors

A.B.C. Motors, Ltd.; Aircraft Urfit Engineering Co., Ltd.; Aylesbury Turned Parts (True Screws), Ltd.; Jack Barclay (Service), Ltd.; Bell and Frome, Ltd.; The Birmingham Guild, Ltd.; Boulton Paul Aircraft, Ltd.; British Replin, Ltd.; The British Petroleum Co., Ltd.; J. R. Bramah and Co., Ltd.; B.X. Plastics, Ltd.; The Broadway Aircraft Engineering Co., Ltd.; G. N. Burgess and Co., Ltd.; Carr Fastener Co., Ltd.; Cass and Phillips, Ltd.; Cramic Engineering Co., Ltd.; A. R. Dart and Co. (Mechanical Engnrs.), Ltd.

Elgar Jig and Tool Co., Ltd.; E.M.C. Engineering Co. (London), Ltd.; Expert Tool Heat Treatment, Ltd.; H. F. Farrow (Engineers), Ltd.; Flexible Shaft Manufacturing Co.; The Franco-British Electrical Co., Ltd.; Gloster Aircraft Co., Ltd.; Guy's Calculating Machines, Ltd; N. Hay, Ltd.; Henderson Safety Tank Co., Ltd.; Hendry and Hawkins, Ltd.; W. Henshall and Sons, Ltd.; Heston Aircraft and Associated Engineers, Ltd.; Edward Hines (Engineers), Ltd.; Hooper and Co. (Coachbuilders), Ltd.

Imperial Chemical Industries, Ltd. (Plastics Divn.); G. K. Jensen and Co., Ltd.; Keim Engineering, Ltd.; Walter Lawrence and Son, Ltd.; London Production Tools, Ltd.; Marshalls' Flying School, Ltd.; Microcell, Ltd.; Murex Welding Processes, Ltd.; Nico Manufacturing; N.V. Tools, Ltd.; S. E. Opperman, Ltd.

J. R. Parsons, Ltd.; A. R. Parsons and Co.; P. B. H. Engineering; Pearson Bros. (Engineers), Ltd.; Pegasus Engineering Co., Ltd.; Walter Potter, Ltd.; Pope and Meads, Ltd.; Presland and Partners, Ltd.; Radium Light Co., Ltd.; R.M.R. Engineering, Ltd.; Royston Engineering Co., Ltd.; Saul Engineering Co.; W. H. Sanders (Electronics), Ltd.; Saunders-Roe, Ltd.; Short Brothers and Harland, Ltd.; John Sills, Ltd.; Singer Motors, Ltd.; Stangers, Ltd.; Straight Lite Reflectors, Ltd.; Robert Stuart (London), Ltd.; Small and Parkes, Ltd.; Styles Instruments, Ltd.; Universal Pattern Co. (London), Ltd.

J. Walker (A.D.), Ltd.; Walsh and McCrea, Ltd.; Wallington Weston and Co., Ltd.; Watton Engineering Co., Ltd.; Whitaker and Shenton, Ltd.; Wingham Bennett, Ltd.; James Young, Ltd.; Young and Wilson, Ltd.

B.O.A.C.'s New Comets . . . .

Early History of the D.H.106

AMONG the recommendations of the first Brabazon Committee, meeting in 1943 to consider Britain's post-War civil aircraft policy, was a particularly bold one concerning the use of the turbojet engine as a means of propulsion. Of the five new types of aircraft which the Committee said should receive immediate attention the fourth was a jet-propelled mailplane for transatlantic use, carrying not less than one ton of mail, having pressurized accommodation for the crew and cruising at 400 m.p.h. This recommendation was contained in the report of the Committee dated February, 1943. At that date, it is worth recalling, Britain had flown only one jet-propelled aeroplane (even the second Gloster E.28/39 did not fly until March, 1943).

The de Havilland Comet, which became the World's first jet transport in service in May, 1952, may seem to be far removed from the idea of a transatlantic mailplane, but this earliest expression of the Brabazon Type 4 transport evolved in the fullness of time into the Comet concept, and credit must therefore be given to the Brabazon committee for the early start which Britain was afforded in this field of transportation. Before describing the steps which led to the Comet of 1952, it may be useful to remind readers of the constitution and objects of the committee.

The first Brabazon Committee was appointed in December, 1942, by the Minister of Aircraft Production and the Secretary of State for Air and was made up of the Rt. Hon. Lord Brabazon of Tara as chairman; Sir Henry Self, Mr. N. E. Rowe and Mr. K. T. Spencer from the M.A.P.; Mr. W. P. (now Sir William) Hildred and Lt. Col. Sir Francis Shelmerdine from the Air Ministry; and Mr. J. H. Riddoch as secretary.

This committee was charged with the task of preparing outline specifications of the types of transport aircraft likely to be wanted after the War (by agreement with the U.S.A., transport aircraft development and production was at a standstill in Britain). It was also asked to indicate which company should be invited to tender designs for each specification, and to investigate the possible conversion of existing types for interim transport use.

In addition to describing five types of aircraft, the report of this committee in February, 1943, noted that their detail specifications should be drafted jointly by the potential user and the proposed constructor, in consultation with the Air Ministry and M.A.P. Accordingly, the Second Brabazon Committee was set up early in 1943 by the Secretary of State for Air, to draw up the user's requirements. Under the chairmanship of Lord Brabazon, it comprised Capt. (now Sir) Geoffrey de Havilland, Gp. Capt. W. Helmore; Mr. W. P. Hildred; Major J. R. McCrindle; Mr. A. C. Campbell Orde; Major R. H. Thornton; and Air Cdre. A. R. Wardle. Mr. J. H. Riddoch was again secretary.

In the course of deliberations by this second committee, the Brabazon Type 4 underwent considerable change. After considerable discussion of the relative merits of turbojet and turboprop engines, it was decided that the latter might hold more promise in the long term, but would take longer to develop, and the turbojet should therefore be used initially. B.O.A.C., in particular, supported the development of a turbojet transport, but the G.P.O. expressed doubts about the need for a pure mail carrier, and by May, 1944, therefore, the Committee had decided to recommend, in its place, a simple jet transport to have an effective range of 700-800 miles carrying a 3,000-lb. payload including 14 passengers.

This was to be powered by two or more simple gas-turbine engines, was to cruise at more than 450 m.p.h. at optimum cruising altitude (about 30,000 ft.) and was expected to have a gross weight of about 30,000 lb. At this same time, it was recommended that a turboprop type should be developed to succeed this aeroplane in the same general category, but, by the middle of 1944, opinion on this point was already beginning to change, and it seemed that the turboprop might not, after all, be required.

The First Project

Meanwhile, before the end of 1943, the de Havilland company started to make design studies along the lines of the earliest Brabazon Type 4 suggestion for a transatlantic mail carrier. One of the first of these studies took the form of an enlarged Vampire (the Vampire fighter prototype flew at Hatfield for the first time on September 26, 1943). It had the same twin-boom layout and wing-root intakes, but had three engines grouped in the rear of the fuselage nacelle. This aircraft had a span of 80 ft. and would have carried six passengers between London and New York, or 9-12 passengers over 1,400-mile stage lengths. It would cruise at 500 m.p.h. at 45,000 ft. The engines projected for this design were Halford H.2s—then on the drawing board as a development of the Goblin and eventually put into production as the Ghost. Construction was to be all-metal.

Although the de Havilland reputation had been built largely upon its family of light aircraft before the War, the company's eagerness to engage in the development of a large, high-speed transport aircraft was by no means illogical. In 1943, it was already committed to the development of turbojet engines for which it wanted to see a post-War outlet. A high-speed jet fighter had been designed and the Mosquito had already established itself as one of the fastest and most versatile of Britain's warplanes. Shortly before the War, transport aircraft experience had been obtained, and links with British Airways and Imperial Airways established, with the production of the sturdy twin-engined Flamingo and the elegant four-engined Albatross. And finally, construction of the original and highly successful D.H.88 Comet had whetted the company's appetite, so to speak, for high-speed, long-distance civil aircraft.

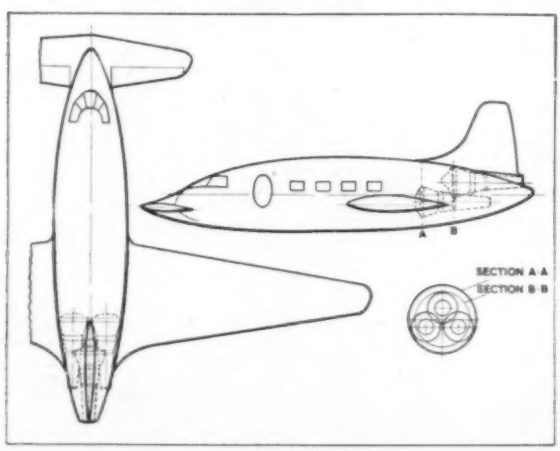
The twin-boom design, with its triple-engine cluster predating by 15 years a similar arrangement adopted in the Airco D.H.121, was only one of several novel layouts investigated by de Havilland in 1943 and 1944. Others included a canard, or tail-first design, and a tailless layout with a swept-back wing.

The second Brabazon Committee had concluded that it would not be helpful to prepare a detailed list of requirements for their Type 4, since the turbojet engine was still in many respects an unknown quantity. It was felt proper to leave as much freedom as possible to the manufacturer, and this was reflected in the outline specification, No. 20/44, issued late in 1944 by the M.A.P. De Havilland had by this time informed the Committee of its design studies and indicated that a prototype could be built in 15 months, starting early in 1945.

Typical of the problems which confronted the designers at this stage was an almost complete absence of information on winds at high altitudes. Both B.O.A.C. and de Havilland were now thinking in terms of the North Atlantic again, but wind conditions at 45,000 ft. were a matter of opinion—considerably influencing the size and shape of the project.

In November, 1944, B.O.A.C. made known to the Committee that they would require 25 of the Type 4 aeroplane; it was agreed that de Havilland should start work in February, 1945, on an aeroplane as described in the specification 20/44, and

(*Continued on page* 631)



This canard design was one of the early project studies which led eventually to the Comet. Also investigated in 1943-44 were twin-boom and tailless layouts.

B.O.A.C.'s New Comets . . . .

(*Continued from page* 630)

known as the D.H.106. In the early stages, this was, in fact, the tailless design already mentioned, which promised to offer substantial advantages over more orthodox designs. Throughout 1945, B.O.A.C. supported this project, recommending that the Ministry of Supply (as the M.A.P. became) should order prototypes. The Corporation's own requirements were re-assessed, as the project grew in size, at 10 aircraft.

As design work progressed, the wisdom of using a tailless layout came increasingly to be questioned, and by the end of 1945, an alternative proposal had been drawn, in which the wing had rather less sweepback, and a swept-back tailplane was added to the basic design. To obtain better information about the behaviour of high-speed tailless aircraft in flight, the D.H.108 was produced, as a modification of the Vampire for pure research, and the first of three examples began its flight trials in May, 1946. Although one of these D.H.108s became the first British aeroplane to exceed the speed of sound (on September 6, 1948) the results of the programme in general confirmed de Havilland's decision to abandon this layout for the D.H.106.

The alternative proposal of October, 1945, which formed the basis of negotiations between D.H., the M.o.S. and B.O.A.C. leading to the initial contracts, was for an aeroplane of 82,000 lb. weight. It was powered by four Ghost turbojets of 5,000 lb. s.t. each, had a sweepback of 40° on the wing main spar, and was offered by de Havilland for Empire or Atlantic service. With some slight modifications, and the weight increased to 93,000 lb., this type was embodied in the first de Havilland brochure for the D.H.106, dated May, 1946, and in this form the Ministry of Supply ordered two prototypes in September.

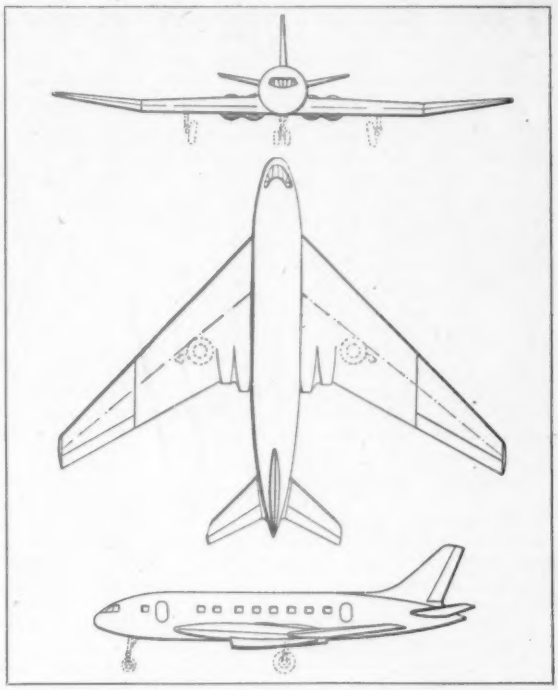
B.O.A.C. stood by their decision to order about 10 examples and maintained the closest contact with de Havilland in the development of the design, but before a contract was placed, de Havilland suggested, and B.O.A.C. agreed to, a major re-design of the project. This halved the degree of sweepback, lengthened the fuselage to increase the passenger capacity, and substituted an orthodox tail unit for the earlier swept-back one. Brief details of the original and revised project are shown in the following table.

	As ordered May, 1946	As revised Nov., 1946
Span	96 ft. 7 in.	111 ft. 0 in.
O.A. length	80 ft. 0 in.	93 ft. 0 in.
O.A. height	24 ft. 8 in.	27 ft. 10 in.
Wing area	1,677 sq. ft.	2,015 sq. ft.
Sweepback at 25 per cent. chord	40°	20°
Thickness/chord ratio	11%	11.5%
Internal fuselage diameter	9 ft. 6 in.	9 ft. 9 in.
Passenger seats	24	32
Max. payload	7,500 lb.	10,000 lb.
Gross weight	93,000 lb.	100,000 lb.
Fuel capacity	6,000 Imp. g.	5,640 Imp. g.
Cruising Mach No.	0.87	—
Max. cruising speed	535 m.p.h.	505 m.p.h.

It can be explained here that de Havilland's biggest problem, from the outset of the project, was to strike the best possible compromise between conventional design and more radical concepts. The essence of the Brabazon IV proposal was to take advantage of War-time developments in powerplants, pressurization and other respects, to "leap-frog" the U.S. aircraft industry with its War-time monopoly of transport aircraft development. This was the reason for de Havilland's investigations of various unorthodox layouts; but it was important not only to be ahead aerodynamically, but also chronologically. Any design features requiring a lengthy development period would delay too long the introduction of the type into service.

Similar arguments influenced the choice of engine. De Havilland preferred the simple centrifugal type despite its higher fuel consumption than axial engine types, because the axial engine was less well developed. At the same time, it was recognized that the axial held great promise for "stretched" versions of the design, and B.O.A.C. were discussing the use of such engines in later versions of the D.H. 106 before the end of 1946.

On the basis of de Havilland's revised proposals of October, 1946, B.O.A.C. asked the M.o.S. to give the makers an I.T.P. (instruction to proceed) for eight aircraft, and this was issued formally on January 21, 1947—representing a significant milestone in the history of the project. Subsequently British South American Airways ordered six aircraft; this order was taken over by B.O.A.C. when the two Corporations merged, the total being finally adjusted to nine of the initial versions. Although



The Comet as first ordered in 1946, with 40° sweepback. Later that year it was amended to have the form in which it was built.

the quantity of aircraft involved was small, the B.O.A.C. order was a valuable "act of faith." No other operator had at this time ordered turbine-powered aircraft—either turbojet or turboprop—and the Corporation's willingness to sponsor the D.H. 106 from the earliest design stage was of great consequence to the speedy production of the type.

From the time of the B.O.A.C. contract to the first flight of the prototype, just 2¼ years later, only one major design change was made. This was to introduce a four-wheel bogie main undercarriage unit in place of the single-wheel unit, in order to reduce the relatively high runway bearing load and the hazard in the event of tyre failure. The new undercarriage was introduced on the first production aircraft and B.O.A.C. accepted an amendment to the guaranteed price in respect of it. At £250,000 a copy (plus the cost of the bogie undercarriage), B.O.A.C., it might be added, were getting a considerable bargain.

Concurrently with construction of the two prototypes, an extensive programme of research, development and testing began at Hatfield. This cannot be fully described here, but on the flying side it included the use of a Hornet and, subsequently, the D.H. 108s to develop the power-operated controls for the D.H. 106; and a Horsa glider modified to have a D.H. 106 nose and cockpit mock-up to investigate visibility and the effect of rain. Development of the Ghost engine for the D.H. 106 was meanwhile being pursued by the de Havilland Engine company. The Ghost first ran on September 2, 1945, and began its flight trials—in the outer nacelles of an Avro Lancastrian—on July 24, 1947. Two Lancastrians were used for Ghost development, and were later joined by a modified Vampire which made it possible to continue the trials at altitudes of up to 50,000 ft. In June, 1948, the engine obtained A.R.B. type-approval for civil use.

On July 25, 1949, the first of the two prototypes of the Comet—as the D.H.106 had been named as early as December, 1947—was rolled out of the assembly shed at Hatfield. Next day was spent completing the pre-flight checks, engine runs and preliminary taxi-ing trials. These were continued early on the morning of July 27, and at 09.50 hr. the wheels left the ground for the first time in the course of a "hop" down the runway. Three more hops followed, and at 18.17 hr. in the evening of the same day the Comet was taken into the air on its first proper flight, lasting 31 minutes.

This marked the conclusion of the preliminary stage of Comet development and the opening of the second stage. Rather less than three years separated the first flight from the beginning of detail design work on the Comet in its final form. Nearly another three years were to elapse before the Comet 1 was in service. An account of the development from Comet 1 to Comet 4C appears on pages 625-629.—F.G.S.

The Fighting Services

Air Gunnery Competition Results

WINNERS of the Fighter Command air gunnery trophies for 1958—the Dacre Trophy for day fighters and the Ingpen Trophy for all-weather fighter squadrons—are respectively No. 63 Squadron at R.A.F. Waterbeach and No. 85 Squadron based at R.A.F. Church Fenton. Flying Hunter F6s, this is No. 63 Squadron's second successive victory in the Dacre competition and the team this year consisted of the C.O., Sqn. Ldr. S. Walker, Flt. Lt. M. Scarrott and Flg. Off. M. S. Davis.

The winning team from No. 85 Squadron operating Meteor NF. 12s and 14s was Flt. Lt. L. J. Buist (pilot) and Flg. Off. J. W. H. Heath (navigator), Flt. Lt. R. B. W. A. George and Flt. Lt. C. O. Hughes, and Flt. Lt. D. G. Hazell and Flt. Lt. H. Goldstone. At the time of the contest the Squadron was commanded by Wg. Cdr. L. G. Martin.

R.A.F. Scholarships

THE next competition for the award of R.A.F. Scholarships will be held during February, 1959. Candidates must have been born on or before June 30, 1943. There is no upper age limit for the competition, but candidates must be able to qualify educationally for entry to the R.A.F. College, Cranwell, or the R.A.F. Technical College, Henlow, before reaching the maximum age for entry.

The age limit for entry to Cranwell is 17½ to 19½ years at the date of entry, and to Henlow, 17 to 19½ years on July 1 of the year of entry. There are two entries annually to Cranwell, in January and September, scholarship candidates normally entering in September, and one a year to Henlow, in October.

Fire-fighting Championships

WITH a total of 851 points, Maintenance Command has won the 1958 R.A.F. inter-Command Fire-fighting Championship held at Kenley, in which Command teams compete in tests of efficiency in handling a variety of fire-fighting and crash equipment. Flying Training Command was second with 849 points, Coastal Command third with 793, Transport Command fourth, and Technical Training Command came fifth.

Held concurrently with the inter-Command competition were an inter-Allied contest won by fire-fighting crews of the R.C.A.F., with the R.A.F. second and U.S.A.F. third, and a two-sided inter-Service contest in which the Fleet Air Arm took first place. The R.A.F. School of Fire-fighting and Rescue, controlled by Technical Training Command, originated at Weeton in 1940, moving to its present base at Sutton-on-Hull in 1942. The inter-Command competition started in 1952 when it was won by Fighter Command.

Australian Army Flying

MOVES for the formation of a flying Wing as an integral part of the Australian Army are understood to have made considerable progress. Support for independent control of its aviation requirements—at present looked after by the R.A.A.F.—has been gaining weight steadily in Australian Army circles since 1950.

The Service requires a Wing of light aircraft, and later helicopters, for staff transport and limited troop movements, casualty evacuation, reconnaissance and the movement of stores and equipment. The R.A.A.F. recently purchased eight Cessna 180 aircraft for Army duties but, because of its other operational requirements, can only maintain 2,000 hr. a year for Army work. Last year the Army flew 4,000 hr., more than half of which were in chartered civil aircraft, and would probably fly more than 5,000 hr. if it had its own aircraft.

The establishment of an Australian Army flying Wing has been discussed widely among Australian Service departments and has met with strong opposition in some quarters on the grounds that it would be an added burden to an already restricted Australian military flying budget. The most likely outcome of this problem seems to be a defence policy giving the Australian Army complete control of its flying activities, including the purchase and maintenance of aircraft, subject to a gross weight restriction of about 4,000 lb.

DUAL INSTRUCTION.—Before taking up his new appointment as S.A.S.O., Fighter Command, on October 10 (THE AEROPLANE, October 17), Air Vice-Marshal R. B. Lees completed the Hunter conversion course at R.A.F. Chivenor. During the course he took the opportunity of flying on a cross-country exercise in a Hunter T.7 with his son, Flt. Lt. R. Lees, left, who is an instructor at the O.C.U.

Whitehall Exhibition Visitors

DURING the seven days on which it was open to the public (September 15-21), 221,000 people visited the R.A.F. Battle of Britain exhibition on the Horse Guards Parade, while a further 11,000 visited the indoor exhibition held at the Air Ministry, Whitehall Gardens. In addition, more than 3,000 listened to bands of the Service playing daily on the parade ground.

The Fighter Operations display in the large marquee on the parade ground attracted more than 16,600 people, and the exhibition in the main marquee 68,600.

R.A.F. Appointments

THE following are among recent Royal Air Force appointments:—

Group Captains: J. R. R. Jenkins to Headquarters, No. 90 (Signals) Group, as Senior Medical Officer; G. R. Gunn, O.B.E., to Air Ministry, as Deputy Director, Medical Organization.

Wing Commanders: J. T. Arklay to Air Ministry for duty in the Department of the Air Member for Supply and Organization (with acting rank of Gp. Capt.); L. H. Moulton, D.F.C., to Air Ministry for duty in the Department of the Air Member for Supply and Organization (with acting rank of Gp. Capt.); O. E. Bartlett, M.B.E., to Headquarters, Maintenance Command, for Air Staff duties; E. O. Barnes to the R.A.F. College, Cranwell, as Senior Medical Officer; R. P. Breen to the Ground Officers Selection Board; O. M. Fraser to R.A.F. Hornchurch as Senior Medical Officer; B. G. Frow, D.S.O., D.F.C., to R.A.F. Luqa, Malta, for flying duties; R. M. W. Henderson to R.A.F. Changi, F.E.A.F., for administrative duties; J. B. Holgate, D.F.C., A.F.C., to R.A.F. Linton-on-Ouse for administrative duties; E. S. Odbert, M.B.E., to R.A.F. Cosford, as Senior Medical Officer; R. S. Peill to the R.A.F. Hospital, Ely, for anæsthetist duties; J. P. Pryer to Air Ministry for duty in the Department of the Air Member for Supply and Organization; I. S. Stockwell, D.F.C., A.F.C., to Headquarters, Fighter Command, for staff duties; W. B. Thorburn to the U.S. on exchange posting; G. H. Wherry, O.B.E., D.F.C., to R.A.F. Bovingdon to command; W. R. Williams, O.B.E., D.F.C., to Headquarters, No. 90 (Signals) Group, for staff duties.

Wing Officer C. E. Warren, O.B.E., W.R.A.F., to No. 31 School of W.R.A.F. Recruit Training to command.

Squadron Leaders: F. C. Barter, A.F.C., to Headquarters, No. 25 Group, for staff duties (with acting rank of Wg. Cdr.); K. R. Perry to the R.A.F. College, Cranwell, for administrative duties (with acting rank of Wg. Cdr.); W. S. O. Randle, M.B.E., A.F.C., D.F.M., to R.A.F. Thorney Island for flying duties (with acting rank of Wg. Cdr.).

An Electronic Necessity

TRANSISTORS have long since been accepted as a *sine qua non* for electronic apparatus needed for installation in confined spaces—for example, in guided missiles—and their production has come to be of major importance. A leading contributor in this field is Semiconductors, Ltd., who have a fine new factory at Swindon where they manufacture germanium and silicon transistors. This company was, in fact, founded in May, 1957, by the Plessey Company and the Philco Corporation of America specifically for making such units by the Philco electro-chemical process. Production started in July of this year—exactly twelve months after construction of the factory at Swindon was put in hand.

The plant is especially interesting by reason of the attention that has been paid in its layout to the needs for rigorous air conditioning. This is particularly important for transistor production and the ambient temperature is controlled to within 2° F. while the humidity is kept within ±5%. The dust content of the air is controlled, by electrostatic and mechanical filtration, to be less than one cubic micron per cubic centimetre of air. Dust control is aided by having no overhead pipes in the factory and all internal surfaces are coated with P.V.C. The factory is zoned to give operational flexibility and facilitate future expansions; for this purpose there are no fewer than 13 separate air conditioning units.

Briefly the process of producing high-frequency germanium transistors is as follows. Germanium, purified by zone-refining to reduce the impurity content to below 1 part in 100 million, is first melted by radio-frequency heating. This is done in a crucible contained in an argon-filled silicon tube; antimony is added at this stage to give the specified electrical characteristics in the finished crystal.

Into the molten germanium, a small "seed" crystal is dropped and as this is withdrawn the germanium crystallizes on to it to form a single crystal about 8 in. long and 1 in. in diameter. This is sawn into thin discs which are lapped and etched to give them a high polish. These germanium discs are next scratched with a diamond tool and cracked into a series of strips which are in turn broken into a number of small rectangular blanks. These blanks are sorted into groups of similar thickness to an accuracy of ±1/20,000 in.

To the germanium blank has to be soldered a nickel tab for support; this tab is welded to the centre one of the three wires sealed in glass in a metal ring and forming the transistor stem. After washing in de-ionized water the germanium wafer is rough etched by two jets of electrolyte impinging on opposite sides of the wafer and producing concentric pits. After this a single jet, used in conjunction with an infra-red monitoring beam for precise thickness measurement, produces a precision etch.

Indium electrodes are next plated into the etch pits and to these are soldered thin nickel "whisker" wires, located precisely at the centre of the electrodes, which are then welded to the stem wires. Finally, the transistor assembly is completed by welding on silicon grease-filled caps.

The foregoing is, of course, a much simplified account of a fairly complex and carefully controlled process which also includes several other intermediate stages of testing and cleaning. For all of this automation techniques are extensively used.

New World Photo-News

Pictures from Howard Levy

Above, a new view of Grumman's Model 159 Gulfstream executive aircraft, which has Rolls-Royce Dart R.Da.7/2 turbojets.

Left, the cabin of the Gulfstream (here seen with seats and test equipment installed) measures 32 ft. 8 in. long and is 73 in. high.

Below, left, the Dart engines and components are purchased as a package from Rolls-Royce and assembled in the U.S. Below, right, the self-contained stairway (seen retracting) makes the Gulfstream independent of ground handling equipment.

Cranfield At Home

AS we briefly recorded last week, the College of Aeronautics at Cranfield kept Open House for two days on October 10 and 11—the first day for 750 or so invited guests and the second for about 6,000 members of the public. Throughout the College, the laboratories and workrooms were thrown open for inspection and the various exhibits—all enthusiastically explained by the staff and the students—were calculated to provide the visitor with a comprehensive picture of the amount and scope of the work done.

As a post-graduate institution designed to give specialist courses in a variety of subjects, the College has eight principal departments. These cover aerodynamics, aircraft design, aircraft economics and production, aircraft electrical engineering, aircraft materials, aircraft propulsion, mathematics, and flight. There is also a Work Study School at Cranfield; and in addition to the main two-year courses a number of short courses on certain subjects are held.

Research work is always an important part of the activities of an institution of this sort and in this respect Cranfield is no exception. The College is, in fact, fortunate in having exceptionally good experimental equipment. For example, it is well endowed with wind-tunnels—the latest of which include a 6-in. by 4-in. intermittent blow-down tunnel giving speeds from $M = 1.4$ to $M = 3.5$; it has a maximum stagnation pressure of 4 atmospheres and was completed in June. At present preliminary running is being done and it was interesting to note that for display, a guided-missile model was mounted in the working section.

Up to the present Cranfield's supersonic tunnel facilities have comprised a 9-in.-square continuous unit with a speed range of $M = 1.5$-2.8 and a 2½-in.-square intermittent tunnel with a speed range of $M = 1.4$-3.5. The former is at present being used for wing/body interference investigations on low aspect-ratio configurations.

Another new wind-tunnel at Cranfield (finished, in fact, only last week) is a low-turbulence tunnel. It is powered by a 150 h.p. motor and a five-bladed fan.

In the 3-ft.-square low-speed tunnel there was an interesting study being made of the flow over cylindrical bodies with various end shapes from which issues a rearward jet. These experiments should provide some useful information with regard to the flow over missile bodies.

Reflecting the success of the College's N.A.T.O. Guided Weapons Course, was a sizeable display of missiles (including Firestreak and Fireflash) and components—some of them from the recent S.B.A.C. Show. These were backed by a comprehensive display of scale models of a large number of guided missiles.

Rocketry of another type was to be seen on the various test beds run by the Department of Aircraft Propulsion. These were described in some detail in THE AEROPLANE for February 21. The most impressive of these displays on October 10 was the firing of the 2,000-lb. s.t. HTP/kerosene liquid propellent rocket, which drew a constant stream of visitors during the afternoon.

Something new on show at the rocket propulsion test site was the little Westland pulse-jet unit developed for their ultra-light helicopter project. This unit delivers 45 lb. s.t. and operates at about 100 cycles per second.

An interesting exhibit in the Department of Aircraft Design was a new undercarriage drop-test rig for the study of landing wheel and shock-absorber leg behaviour. The wheel is dropped on to the surface of a 12-ft.-dia. wheel which is rotating horizontally to simulate landing speeds of up to 180 ft./sec. Various combinations of drag and side load can be reproduced by turning the undercarriage leg about its vertical axis. At present the wooden "runway" surface has two 6-in. humps on it and these will be progressively altered as the experiment proceeds.

Another interesting piece of test apparatus on show in this department was that used for investigating helicopter ground resonance. This started as a study in connection with the Skeeter and had a three bladed rotor and three-point undercarriage. It has now been modified to have a four-bladed rotor and a quadri-cycle damping system representing the undercarriage. In this form it is representative of the Saro P.531 and is being used for general investigation of the effect of various parameters on ground resonance.

The Department of Flight were showing their aircraft which included a Lancaster on the top of which is mounted a Gnat mainplane in the vertical position. In addition to improving the directional stability of the Lancaster this "fin" is being used for research under M.o.S. contract into the effect of incidence and speed on the transition of laminar boundary layers on a swept wing. A similar experiment, on a more modest scale, to provide students' thesis material, is being done with an Anson.

The Dart Herald Accident

A REPORT which has been sent out by Handley Page to prospective buyers of the Dart Herald gives a very detailed account of the events which immediately preceded the accident on August 30, and of the results of the investigation into the causes of this accident. Here are the principal points made in the report.

While flying at 6,000 ft. Sqn. Ldr. H. G. Hazelden heard a loud bang from the starboard engine, which immediately caught fire. He "noticed the r.p.m. decreasing rapidly on this engine and immediately took the necessary action to close the high- and low-pressure fuel cocks and to feather the propeller. The fire extinguisher had no apparent effect, so he throttled the port engine and descended at 150-160 kts. with the intention of crashing in the first available open space.

"In a very short time," the report continues, "the aircraft began pitching and, although the pilot felt that a major break-up was imminent, he was still able to control it with the elevator. Some gentle rolling from side-to-side also occurred and, as the ailerons were beginning to jam, he had to use considerable force to overcome it.

"At about 1,500 ft. there was a much more violent roll, which required full port aileron to correct. This was the point at which the starboard engine and nacelle dropped away from the aircraft, but within a few seconds the machine righted itself although the pitching was somewhat worse. As Sqn. Ldr. Hazelden approached the field he had chosen he noticed that it had high-tension cables running across it. There was insufficient space beyond the cables before the trees at the far end, so he forced the aircraft on to the ground, touching down at about 130 kts., and slid under the cables, one of which struck the tip of the fin. . . .

"Rolls-Royce have inspected the Dart engine concerned and have reached the following conclusions:—

1. The initial failure was of the auxiliary gearbox breather-layshaft, which fractured in the undercut between the splines and the threaded portion.
2. Failure of this shaft interrupted the flow of oil to the turbine bearings.
3. The bearings failed and allowed the high-pressure turbine disc to move rearwards and foul the interstage seals circumferentially.
4. The resultant grooving and overheating of the turbine disc caused it to fail in tension.

"Portions of the turbine-disc rim severed the fuel pipe and an engine-mounting strut and, in the few seconds which elapsed before the fuel-cock switches were operated by the pilot, several gallons of fuel flooded the engine bay. Such a quantity of fuel is considered by the experts to be sufficient to cause an uncontrollable fire. The fire extinguisher had been found to have operated. The accumulation of fuel poured out of the holes made in the nacelle by the turbine disc and flowed back along the outside of the nacelle before entering the undercarriage-door gaps, where the fire continued to burn inside the wheel-well.

"Although the fire-wall was intact, the skin panels behind it were burnt through, as well as all the nacelle frames and the whole of the rear of the nacelle. The undercarriage doors fell away and the starboard landing gear may have been partly lowered. When the nacelle-attachment points finally burned away the engine and the remainder of the nacelle fell away and were found 1¼ miles before the point of touchdown. In falling away, the nacelle pulled away the fuel pipes from the wing-tanks and allowed a free flow of fuel to maintain the fire under the wing, which reached back to the starboard tailplane, half of which was burned off and fell away 200 yards before touchdown."

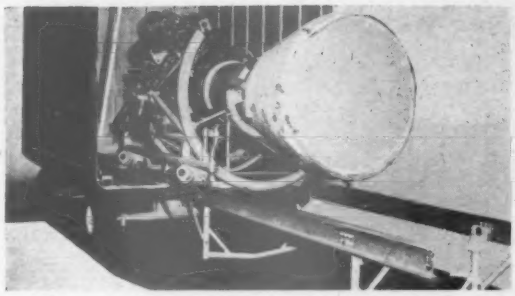
There have been two auxiliary gearbox breather-layshaft failures on the Dart 520 series three-stage turbine engines. Both failures were identical and are associated with a certain manufacturing batch. Action has been taken to replace these with strengthened layshafts. In addition, the low-oil-pressure warning-light switch has been repositioned to sense the oil pressure to the turbine bearings, so that, in the event of a cessation of the oil supply an immediate indication would be given and feathering action taken before a major failure occurs.

The aircraft which crashed had finished its flying trials, involving about 200 hours. Only one or two tests remained to be completed before a C. of A. was granted. The second prototype Dart Herald is now nearing completion.

(*Continued from page* 607)

JAPANESE NEPTUNES.—The U.S. Navy announced on October 15 that a contract had been signed between Lockheed and Japan whereby 42 Neptune anti-submarine patrol bombers will be built in Japan by the Kawasaki Aircraft Co. Costs will be shared, and Lockheed will provide technicians, advice and materials.

CZECH AIRCRAFT SALES.—Gp. Capt. E. L. Mole, who has been granted sole distribution rights in the U.K. for the Super Aero aircraft, has purchased control of the Aircraft and General Finance Corpn. and will handle the sales of Czech light aeroplanes in this country. Some interesting civil types, including the Super Aero 45, the L40 Meta-Sokol, L60 Brigadyr, the Zlin Trener and the Heli-Baby, as well as several aero-engines, are available for import from Czechoslovakia against Sterling purchase under the terms of the U.K./Czech Trade Agreement. Full details of these may be obtained from Gp. Capt. Mole at 3 Red Place, Green Street, London, W.1.



MISSILE POWER.—Details of the Thor IRBM's Rocketdyne motor can be seen in this view of the motor entering a mobile vehicle of the type to be used for air transport of U.S. ballistic-missile motors.

SPECTRE POWER. — The D.H. Spectre D. Spe. 1, 2 and 3 are all of 7,000-lb. thrust. The D. Spe. 1 and 3 are variable-thrust and the D. Spe. 2 is a fixed-thrust rocket engine.

NORATLAS EXPORTS.—Three Nord 2501 Noratlas transports have been ordered by Arkia, the company responsible for internal airways in Israel. The Israeli air force has also ordered the Noratlas recently. Total orders for the type and its variants are now 353, of which 214 have been delivered. Of the total, 41 are for commercial operators.

Commercial Aviation Affairs

ELAND-CONVAIR NEWS. — The second Eland-Convair, a 440 converted by PacAero at Santa Monica, made its first flight on October 14. The occasion marked an intensification of Napiers' sales effort in respect of turboprop transports in general and Eland conversions of existing types in particular. On October 16, the original Eland Convair 340 was damaged by fire, when hydraulic fluid leaked on to the brakes as the aircraft was taxi-ing in after rigorous braking trials at Palm Springs, California.

HIGH-DENSITY VISCOUNT.—Conversion of a B.E.A. Viscount 701 to high-density configuration has recently been completed. This aircraft, G-AMOK, now has 60 passenger seats and built-in airsteps at the forward door. B.E.A. propose to use high-density Viscounts on domestic trunk routes.

B.E.A. FARES CUT.—Return fare between London and Cyprus has been cut by B.E.A. from £108 to £85 on twice-weekly night flights by Viscount starting on November 1.

BRITANNIA TROOPING. — Air Charter completed the second of four charter flights between this country and Christmas Island when their Britannia 307 arrived at Stansted on October 12. It had carried 112 Service personnel and a crew of 15 from Christmas Island via Honolulu, Vancouver and Montreal in a flying time of 28 hours.

F-27 ORDERS. — Fairchild have announced orders for the F-27 from Aloha Airlines (two and an option on two); Trans Mar de Cortes (one and an option on one); and R. J. Reynolds Tobacco Co. (executive version). Basic price of the Fairchild F-27 has been increased by $45,000 to $635,000; the F-27A with Dart R.Da.7 engines has been increased by $35,000 to $695,000. In Holland, Fokker have confirmed that the Royal Netherlands Air Force has ordered twelve Friendships, including two with V.I.P. interiors.

SERVICE STATION.—On October 16 a new Dunlop service station was opened at London Airport; it is claimed to be the biggest tyre depôt at any airport in the country. This new service station will stock Dunlop aviation equipment as well as tyres.

LOT SHOPPING.—It is reported from Warsaw that the Polish airline LOT plans to evaluate Russian and Western turbine transports at Okecie Airport soon. Aircraft involved are expected to include the Viscount, Friendship, Comet, Electra and Il-18. When LOT introdueed their Warsaw-London service with Convair 340s earlier this year, several executives of the airline visited Weybridge and expressed the hope that they would be able to buy Viscounts.

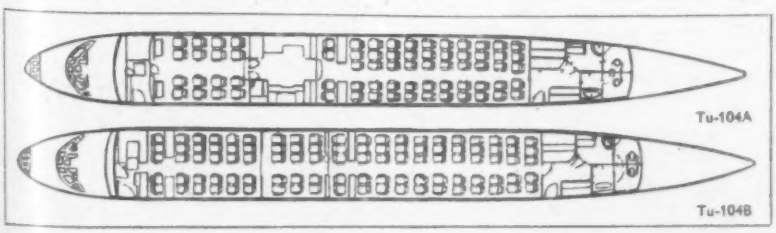
L.A.P. PIPELINE.—Shell-Mex and B.P., Ltd., proposes to install a pipeline to carry aviation fuel from Walton-on-Thames to London Airport. Parliamentary sanction is required and a private bill is to be introduced.

CANADIAN HEARINGS BEGIN.—The Canadian Air Transport Board began its hearings in Vancouver on October 6 into the application by C.P.A.L. for permission to operate a transcontinental air service. On the first day of the hearing Pacific Western Airlines announced that it had withdrawn its similar application and was supporting the C.P.A.L. claim.

DC-8 ORDERS CUT.—National Airlines has reduced its order for DC-8s from six to three as a result of the proposed Pan American-National lease agreement and a reassessment of future traffic. Delta has reduced its order for DC-8s from eight to six because of the general recession in airline business.

A Tu-104 LOST.—Flying on the regular Aeroflot service from Peking to Moscow, a Tupolev Tu-104A crashed 400 miles east of Moscow on October 17. All occupants, including 65 passengers, were killed. This is the first reported accident to a Tu-104 involving passenger fatalities, but several other incidents, particularly during landings, have been reported, when passengers have been injured and aircraft damaged.

STRETCHED TUPOLEV.—A new version of the Tupolev Tu-104, the Tu-104B, has been produced, with the fuselage extended by 1.2 m. (3.9 ft.) to increase passenger accommodation from 70 to 100. The central galley of the Tu-104 and 104A has been relocated forward, and the cabin floor raised to enlarge the available baggage space. Total payload of the Tu-104B is thus quoted by A. A. Archangelskii, deputy chief designer of the Tupolev syndicate, as 12,000 kg. (26,455 lb.) instead of 8-9,000 kg. (17,637-19,842 lb.) as in the Tu-104A. It is made up of 8,000 kg. of passengers, 2,000 kg. of baggage and 2,000 kg. of freight, compared with 5,800, 1,400 and 1,000 kg. respectively for the Tu-104A. Performance is the same, but take-off and landing characteristics of production Tu-104Bs will be improved by increased flap area. (See left.)



News About People

BRISTOL MANAGER.—Mr. R. W. Jay has been appointed spares manager of Bristol Aircraft, Ltd., in succession to Mr. C. A. R. Riddle. Mr. Jay was formerly assistant commercial manager for the Britannia.

SIMMONDS APPOINTMENT.—Mr. Geoffrey R. Simmonds has been elected president and a director of Simmonds Aerocessories, Inc., of New York, filling the vacancy created by the death of Mr. William Enyart in June. He is the son of Sir Oliver Simmonds, head of the Simmonds Group of companies, and acquired U.S. citizenship in 1954.

LOCKHEED DIRECTOR. — Mr. Herbert Hoover, Jnr., former Under-secretary of State in the U.S.A., has been elected to the board of the Lockheed Aircraft Corpn. There are now 15 members of the board.

FRANKLIN MEDALLIST.—Mr. Donald W. Douglas, founder and chief executive officer of the Douglas Aircraft Co., Inc., has been awarded the Franklin Medal, the highest award of the Franklin Institute, for "his creative engineering in the field of aeronautical design as exemplified in all of his work but particularly in the DC series of transport aeroplanes, and in recognition of his engineering genius which has provided inspired leadership for the technical developments of his industrial organization."

HENLOW GROUP.—A new aero-thermodynamics laboratory at the R.A.F. Technical College, Henlow, was opened by Sir William Farren, technical director of A. V. Roe and Co., Ltd., on October 9. Seen here inspecting the new combustion chamber test rig (presented by J. Lucas and Co., Ltd.) are left to right, Air Cdre. T. U. C. Shirley, C.B.E., (Commandant of the College); Sir William Farren; Mr. J. Morley (chairman, J. Lucas (Gas Turbine Equipment), Ltd.) and Sqn. Ldr. C. E. Wells (Henlow College Staff).

HILLER POSTS.—Mr. J. B. Black, operations division manager of the Hiller Aircraft Corpn., and Mr. J. T. Dresher, finance division manager, have been elected vice-presidents of the company while retaining their present positions. The board now has 13 members.

NAV. OCCASION. — At the annual reception of the Institute of Navigation, held on H.Q.S. "Wellington" on the Victoria Embankment on October 15, are seen, left to right, Mr. A. M. A. Majendie; Capt. F. J. Wyl'e, R.N., Institute president, and Mr. J. E. D. Williams, Institute Bronze Medallist, 1958.

Photographs copyright "The Aeroplane"

AERO GOLF.—At the autumn meeting of the Aero Golfing Society on October 3 the Cellon Trophy was won by Mr. D. Hepburn with Mr. J. Mayes as runner-up. The four-ball bogey match was won by Mr. P. L. W. Morton and Mr. T. F. Mitchell; Mr. F. A. Laker and Mr. A. K. Major were runners-up.

TEST PILOT IN U.S.—M. J. Lithgow, Vickers-Armstrongs' deputy chief test pilot, has been studying and flying American naval aircraft in the U.S. He spent a week in Dallas where he flew the Chance Vought Crusader.

SALES MANAGER.—The Warwick Production Co., Ltd., a member of the Almin Group of companies, has appointed Mr. R. W. Devereux as sales manager.

HEAT CONTROLLER.—Newly appointed sales manager of the Thermostat Division of R. B. Pullin and Co., Ltd., is Mr. R. W. Jelbart, T.D., M.N.I.H., A.S.M.A.

Military Aviation Affairs

VICTOR RECORD.—On October 14 a Bomber Command Victor on a training flight from Gaydon set an unofficial record for a U.K.-Malta flight, covering the 1,310 miles from Farnborough to R.A.F. Luqa in 2 hr. Piloted by Wg. Cdr. D. Iveson, the V-bomber's average speed was 655 m.p.h. The official record between London and Valletta is held by a R.N. Scimitar, which covered the 1,298 miles in 2 hr. 17 min. 27 sec., an average speed of 588.05 m.p.h. This was set up in June last.

ARMY AIR CORPS.—A new powder-blue beret has been approved by H.M. The Queen for the Army Air Corps. It has an embroidered badge consisting of an eagle and laurels surmounted by a crown.

ITALIAN ARMAMENT.—Under the U.S. mutual aid programme for NATO countries, Italy is to receive its first Nike-Ajax SAM missiles early next year. Some 680 Italian officers and men are shortly to graduate from the anti-aircraft and guided-missile school at Fort Bliss, Texas.

MISSILE TRAINING.—The West German Army is to start training in the use of Honest John SSMs in the next few weeks. Two mobile launching pads with 24 rockets have been ordered by Germany.

GNAT ACCIDENT.—A Folland Gnat from R.A.F. Boscombe Down crashed near Stapleford on October 15. The pilot, Sqn. Ldr. E. J. Roberts, was killed.

CATERING SCHOOL. — The R.A.F.'s new school of catering was opened at Hereford on October 9. It replaces three separate establishments.

COLOUR PARADE.—At a ceremony held at R.A.F. St. Mawgan on October 10 the standard of No. 201 Squadron was paraded to commemorate the Squadron's return to the active list. No. 201 has been re-formed from No. 220 Squadron, which has been disbanded.

Twin-engined Weight-lifter

A SMALL twin-engined American helicopter that seems to be showing great promise as a utility weight-lifter is the Omega Aircraft Corporation's BS-12 or Omega Twin. It has a single four-bladed main rotor, belt driven by two 225 b.h.p. Franklin flat-six engines, and an orthodox tail anti-torque rotor. A maximum cargo load of 1,000 lb. can be lifted—or the machine used for carrying four passengers or a mixed load of, say, two passengers plus 360 lb. of external load. A noteworthy feature of the Omega Twin is its ability to fly on one engine.

Captain A. B. H. "Jimmy" Youell, who has recently been to the United States and flown the BS-12, speaks enthusiastically of its capabilities. He can certainly speak with some authority for he is a helicopter pilot of long standing and has had an extensive experience of rotary-wing craft. He tells us that he has undertaken to act as the European agent for the Omega. Major G. E. Woods-Humphery acts as consultant for Omega's foreign sales.

Designed specifically for utility operation, the BS-12 has a

cabin with accommodation for four passengers and a pilot. Behind this and directly underneath the main rotor is a "cargo area" from which can be slung all manner of bulky freight loads either in a pod or a net, or simply suspended as a separate unit.

On each side of, and above, the main cargo area, the two powerplants are carried externally on welded steel-tube mounting structures. They are mounted athwartships with their crankshafts "swept back" 15°.

The main rotor gearbox at the base of the rotor pylon structure is driven from these engines by a multi-belt system. This makes use of standard Goodyear wedge-type belts and, as the entire powerplant drive is exposed, these can be inspected and replaced with a minimum of trouble. Omega claim that this single belt-drive arrangement "provides unique vibration dampening which reduces stresses and wear on the subsequent motions of the transmission."

The mounting structure and transmission has been stressed to take engines of up to 275 b.h.p. and modifications are already in hand for the accommodation of 310 b.h.p. engines in production versions; the standard powerplant selected for production BS-12s is a 310-b.h.p. Lycoming. The external mounting arrangement greatly simplifies this provision of alternative powerplants.

Two identical two-bladed fully articulated rotors mounted one above the other at 90° are splined to the same shaft to form a single four-blade unit having a diameter of 39 ft. The blades are made by the Parsons company and are of laminated birch and spruce covered by glass-fibre, with a stainless-steel

leading-edge protective cover. If required, the blades can be adapted to incorporate Reaction Motors' tip-jet units for take-off and emergency performance boosting. The tail rotor is a two-bladed unit and is mounted at the end of an open framework welded steel-tube tail boom.

One of the primary objectives in the design of the Omega Twin has been to keep the first cost and the maintenance costs of the aircraft to as low a figure as possible. The Corporation claim to have succeeded in this because the BS-12 has been designed throughout on a commercial basis and military requirements and procedures have been avoided.

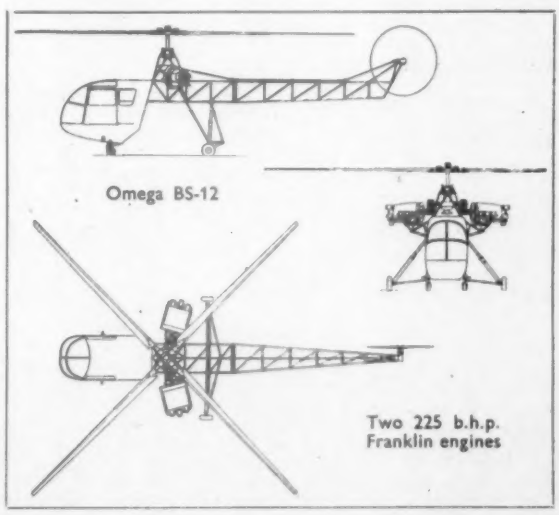
A prototype and three pre-production machines were initially laid down and in the case of these last-named the first cost is expected to be in the region of $70,000 (about £25,000) each. Nine more production-type aircraft have been started. And on the basis of a production order for 100 machines, Omega reckon that the first cost would be reduced to $50,000 (£18,000) or less.

A 100-hr. tethered test programme was completed with the prototype in October of last year and since then it has accomplished a considerable amount of development and demonstration flying. The latest reports from Omega are that all the C.A.A. certification requirements have been met—with the exception of strain gauge tests on the rotors which are now in progress. The Corporation expect to receive final certification for the machine before the year is out.—F.T.M.

Technical Data (Franklin engines)

WEIGHTS.—Empty, 3,125 lb.; useful load, 1,440 lb.; max. fuel load, 480 lb.; oil, 45 lb.; loaded weight, 4,565 lb.

PERFORMANCE.—Max. speed at sea level, 95 m.p.h.; optimum cruise at sea level, 77 m.p.h.; inclined climb, 1,000 ft./min.; time to 5,000 ft., 5.6 min.; hovering ceiling with ground effect, 4,800 ft.; service ceiling, 12,400 ft.; absolute ceiling, 13,000 ft.



Private Flying

H.J.C.'s CLUB COMMENTARY

● IN THE past we have frequently urged the establishment of an aeronautical museum, and it is specially gratifying to learn from the Royal Aeronautical Society that this body, in conjunction with the Society of Licensed Aircraft Engineers, is about to begin work on repairing and maintaining the vintage aircraft known as the Nash Collection, which the Society acquired in 1954. A group of volunteers from both organizations has been formed for this purpose, and a hangar at the R.A.F. station Hendon, has recently been made available for storing and housing the aircraft.

Chief engineer of the group, known as the Historic Aircraft Maintenance Group, is Capt. E. D. Ayre, a past president of the S.L.A.E., who has already made a preliminary inspection of the aircraft and started to collect the necessary equipment. He will supervise the team, some of whom have intimate knowledge of aeroplanes of the 1910-20 period.

The Nash Collection at present has a Blériot XIa (1910); a Blériot XXVII (1911); a Caudron G.III (1912); a Farman F.40 (1913); two Avro 504s (1914); a Sopwith Camel (1917); a Fokker D.VII (1918); an S.E.5A (1918) and a Wellington Mk. 10, presented by Vickers-Armstrongs in 1956.

A good point of the Group's policy is that the aircraft will be preserved rather than renovated, so that they will remain as near as possible in their original form and the old-time craftsmanship will not be lost. It is hoped that the Collection will eventually form part of a national collection of aircraft.

● SOME IDEA of the vast amount of flying which is done in the U.S.A. can be gathered from figures issued by the Civil Aeronautics Administration, Washington, about the number of qualified pilots there are in the States.

Since the last survey the number of pilots has risen by 43,041 to 809,349. These are made up of student pilots, 98,498; private pilots, 448,470; commercial pilots, 237,149, airline transport pilots, 16,900; helicopter pilots, 473; glider pilots, 627; flight-instrument certificated pilots, 6,955, and other pilot categories, 277. Additional to the helicopter pilots, 5,092 private, commercial and/or airline pilots hold helicopter ratings, and there are 3,360 similar pilots who also hold glider ratings.

A total of 165,008 " other airmen," which means groundcrew and aircrew not qualified as pilots, hold various licences.

California has most pilots—no fewer than 101,790. Alaska has more pilots per population than any other State—4,151 for an estimated population of 215,000.

● ALTHOUGH Croydon Airport is scheduled to be closed on December 31, so far as flying is concerned, the clubs there keep on flying with enthusiasm. The **Experimental Flying Group** has now reached 500 hr. this year, and hopes to put in another 100 hr. before the threatened end of flying. P.P.L.s have been gained by Messrs. Ian Black and E. Timberlake, bringing this year's total to six. Miss Elizabeth Tallett has flown solo.

● LAST MONTH the **Oxford Aeroplane Club** flew 139 hr., more than 200 hr. less than in August, but the weather was mainly responsible for that.

Mr. Ken Scott, who has done all his flying with the club, has just gained his assistant instructor's rating.

● RESULTS of contests held by the **Lancashire Aero Club** are: Pemberton landing competition, H. Burrows; Rodman landing competition, R. Stockfis, and the Crossley navigation competition, Mr. J. Devine. Mr. Harker of the **Southport Aero Club** won the Hart landing contest for visiting clubs.

In September Lancashire flew a total of 127 hr. Mr. R. L. Edwards gained his P.P.L.; A.T.C. Cdt. Hodgkinson and Mr. D. Young have flown solo.

Gliding Notes

by Dr. A. E. Slater

A UNIVERSITY gliding club has such a quick turnover that it must make extra efforts to keep up the recruiting rate. Cambridge lays on a special meeting each October, at the beginning of the academic year, and notices are posted in all the colleges asking people to come to a lecture room in Trinity and learn what this gliding is all about. After being baulked for many years from attending this show—once by running into a fog bank at Hitchin—I got there at last on October 10 to find about 50 people present.

This time there were more non-members than members, though usually, I learned, it is the other way round. However, last year's entry was a record with 70 new members, so there must be other ways of bringing them in. A " snowball " process is believed to be responsible; the initiated take their friends along to Marshall's aerodrome, and so it goes on.

After free coffee all round, Ken Machin opened with a review of the whole subject, starting with the historic days of solo training when you first did ground-slides, then went up 4 ft., then 20 ft., then back to 4 ft. because the instructor realized he had mistaken you for someone else. After this a fine colour film by Ken King was shown, which gave special emphasis to soaring flights over the Long Mynd during club camps there, interspersed with occasional shots of gulls doing the same thing over a cliff.

* * *

A film of this kind evidently makes the strongest appeal of all, since Stuart Waller, who spoke next, said that it was the film shown at one of these meetings which really decided him to take up gliding. And it was not until a second film had been shown, that subscriptions and flying fees received their first mention.

While the full annual subscription is seven guineas, with no entrance fee, there is a peculiar category called " Trial Membership," which " lasts till the end of the quarter in which the member joins or until the member flies solo (whichever is longer). . . . On going solo the trial member becomes liable to pay the balance on the full flying subscription from the date of joining in the first place."

* * *

TIME was when the British gliding fraternity could barely be persuaded to support a single magazine. Then a year before the War the Midland Club started up a multigraphed publication called *Wing Tips*, which is still in production. Now, nearly all the principal gliding clubs produce newsletters with varying degrees of regularity, and recently the London Club had two—producing a weekly news sheet besides its *Gazette*.

The newsletter habit has suddenly spread to the industry with " Number 1 " of a " News Letter " brought out by Slingsby Sailplanes. Like the similar feature produced by the German firm of Scheibe for the past few years, it is intended primarily for users of the firm's products.

We start with news of the Swallow, which has been put into production at an " initial " price of £750 ex works, or £490 in kit form. Its best gliding angle is estimated to be 1 in 26 and minimum sink 2.5 ft./sec. (0.76 m./sec.).

Next comes a promise of hire-purchase terms in the near future, conforming to the present legal requirement of one-third down and the rest over two years.

To prevent canopies blowing open when pilots have forgotten to fix them down before walking away from the glider, a new kind of catch has been introduced for Skylarks and Eagles which engages automatically as the canopy is closed. People who let this happen after locking the window are told how to get the catch open from outside, because one pilot who did so was seen dismantling the canopy window with a screwdriver.

Soon we may be spared the horrifying sound of tails hitting the ground with a resounding bang after the nose has tipped forward on the launching or landing run. A spring tail-skid has been produced with a possible deflection of 5 inches, and it can be fitted " retrospectively," which means not only that it looks backwards but that it can replace any skid already fitted.

* * *

KENT GLIDING CLUB'S treasurer works out the club's expenses in terms of cost per launch. Thus, during August, " running expenses " were 2s. 2d. per launch, but " overheads and administration " were 3s. 5d. per launch, making 5s. 7d. per launch, which is a good deal more than the pilots actually pay. The rest obviously comes out of annual subscriptions.

Particularly interesting is the number of launches per gallon of petrol; it was 3¼ for the year but only 2¼ during August. Is that because a longer launching run is needed in the thin air of summer? Anyway, if the glider merely does a circuit, lasting about 4 minutes, it is operating at a rate of no more than 10 air miles per gallon, if that. Considering that the winner of the 1923 ultra-light aeroplane contest at Lympne covered about 80 miles to the gallon, glider circuits are rather preposterous, considered as an end in themselves—as preposterous as those people who regard them as a means of getting Youth (with a capital Y) into the air, rather than as an introduction to soaring flight, which can be their only justification.

Correspondence

Publicizing British Missilemen

FOR the past 10 years I have been actively engaged on rocket engine research and development.

At last after so many years a little is allowed to be published of the British effort in the rocket field.

The Black Knight made history by being successful on its first launching; how much of the story are the public going to enjoy? Or are we once again going to let a brilliant British achievement pass into the background?

Your articles on the Black Knight (THE AEROPLANE, September 19 and October 10) are, as we know, restricted by security, but what of the story behind the missile?

Surely a story about the scientists and engineers who probably worked for years solving the hundred and one problems, their names and background, would break no security regulations.

Aylesbury, Bucks. "DISSATISFIED."

Buying Abroad

I WISH to take up your editorial of September 5 where you decry the purchase of freighter aircraft from the U.S. for use on Commonwealth routes. It is a matter of preparedness. If we order a British prototype now, as you suggest, then we shall have to rely upon Comets, Beverleys and Britannias, with all their limitations and shortcomings, until 1965 or, at worst, 1970.

Whether or not the Ministry has so far financed a prototype is beside the point. Can we afford to wait five or more years, in a state of very limited preparedness? As for dollars, the Treasury seems to be willing enough to purchase large airliners, from which the taxpayer stands to gain little, at best.

I will suggest a compromise which has worked admirably before—U.S. airframe, British engines. We should thus stand to gain the most from the civil market potential. When we receive our British prototype that market may have been filled.

Cheshire. A. B. KNIGHT.

The Turbojet and Turboprop Controversy

S.H.E.'S article, "The Cricket on the Hearth," in your issue of September 19, is probably the neatest and most accurate summary of the position of the British aircraft industry vis-a-vis the international scramble for the civil air transport aircraft market that has yet appeared in print, and he is to be congratulated on it.

It has been patent to many of us who, like myself, have no connection with the aircraft industry, that truly monumental blunders have been made at policy level in deciding the types and timing of the various projects we have to offer today, but the keys to the situation are few.

In the pure-jet field the decision to proceed with a redesigned Comet was a bad one. Had the improved Comet 4 been available for airline service from early 1957, the bid would probably have paid off, but with its service date as late as end 1958/early 1959 it would have been better to dump it and have put the effort into a new design.

Perhaps an even worse decision was to order a second generation turboprop for B.E.A. in spite of the already mounting evidence that from 1959 onwards they would have to meet jet competition in the 500-600 m.p.h. class on every major route. The odd reasoning which led to this order is thrown into even sharper perspective by the policy of ordering a short-range jet while the ink was hardly dry on the Vanguard contract. The quaint philosophy of this 400 m.p.h. competitor to 600 m.p.h. jets may lead—and probably will lead—to the emergence of a very fine aeroplane, but because it will not be available until 1960, the Electra appears to be collecting most of the not very many orders for this class of aeroplane. It seems to me that the Vanguard has merely taken over a part of the potential market for developed Britannias without having created one for itself. I hope I am wrong on this forecast, but that is the marked impression that I have gained.

The proof of the pudding is in the eating, they say. If that is so, then the proof is to hand. We have been offering for a couple of years or more a very strong hand in turboprops—Britannia, Herald, Viscount and Vanguard—and in pure jets an indifferent one, the Comet. After the first wave of buying of the "600-m.p.h. plateau" U.S. jets, the business has settled down again to the purchase of small lots of small and medium aircraft. But what is the position? Are we getting a large share of this business, which is of the type we would consider applicable to our types on offer? The answer is simply no! The turboprop market goes largely to the Electra (yes, I know the financial arrangements) or to the Friendship, and in the jet field to the Caravelle. Because they are what the customer wants (or nearly so) at the time when he wants it. Equally, the announcement of the Freightercoach two years earlier would probably have resulted in its adoption as the standard NATO tactical transport.

S.H.E.'s "imagineering" fourth dimension, Time, is the one thing we have consistently ignored—with a consistency which would be admirable if usefully applied.

I am minded of that old Mandarin proverb:—

"Time is but the concern of slaves and foreign devils."

Today the "foreign devils" get the business.

Southport, Lancs. ALAN MOORCROFT.

[S.H.E. has undertaken to reply, and not least to deal with the suggestion that the Comet is "indifferent."—ED.]

Groundabout

Cap and Canaveral.—Noel "Cap" Capper, Scottish Aviation chief test pilot and sales manager, has asked me to deny that the U.S.A.F. Moon vehicle, Pioneer, turned back because it couldn't find any place on the Moon big enough to land on.

*

Reporter, interviewing a Pan Am. representative: "What does Pan American have to say now about being the first to start an Atlantic jetliner service?"

Pan Am. rep.: "No Comet."

*

Metricate and Complify. Once more the possibility of changing to the metric system for measurements, weights, etc., which we all think is desirable but too much trouble, is being investigated. Why not consider metricizing time, too? Say, 100 sec. = 1 min.; 100 min. = 1 hr.; 10 hr. = 1 day; 10 days = 1 week; 35 weeks plus one special 15-day holiday week = 1 year. Dispense with months (because I can't work them out). Think how world production effort would benefit from the subsequent 8-day working week, though some of us non-Union people work that kind of week right now.

*

Variations on a Phrase

"The successful airline is the one that gits thar quickest with the mostest."—*Clifford Lawson-Reece, Chairman of Aviation Forum.*

"'Cruise Control' is getting the mostest from the leastest."—*J. W. Ritchie, Asst. Snr. Operations Engineer, B.O.A.C., in "Plane Facts."*

With acknowledgements to Gen. Nathan Forrest, American Civil War soldier.

*

All the Time and Everywhere. A friend holidaying in Spain writes rejoicing in the total absence of aviation where he is. I once tried getting away from it. We motored vaguely towards North Devon, where the nice pub we found was run by an ex-fighter pilot; R.A.F. Chivenor (flying at 07.30) was just down the road; an R.N.Z.A.F. squadron leader and his family came to stay; and on the sands we met D.H. test pilot Geoffrey Pike and family. I just seem to *attract* aviation to me. Even my accountant, whom I met in completely unaeronautical circumstances, turned out to be a glider pupil of the Surrey club. Now, of course, my credit is soaring.

by Gyrens

NOTES AND EVENTS

OVERSEAS MANUFACTURE. — Agreement has been reached between Marconi's Wireless Telegraph Co., Ltd., and Jugoimport, a Yugoslavian import agency, for the manufacture in Yugoslavia of Marconi sub-miniature Automatic Direction Finders, Type AD722. Marconi will supply parts for assembling, and an initial order for the sub-assemblies has been placed with the company, along with a complementary order for completed units.

ARGOSY FIRE PROTECTION.— Fuselages of the Armstrong Whitworth A.W. 650 Argosy turboprop transport are to be fitted with Pyrene aircraft fire-protection equipment. This will include Pyrene impact crash switches; pistol-grip CO_2 hand fire extinguishers for flight-deck areas; wet extinguishers for passenger- and freight-accommodation areas and, where specified, smoke detectors to give immediate visual and/or audible smoking warning.

VICKERS-SMITHS AGREEMENT.— Vickers-Armstrongs, Inc., of Arlington, Virginia, has been granted exclusive selling rights in the U.S.A. for all aviation products of Smiths Aircraft Instruments, Ltd., and other companies of the S. Smith and Sons (England), Ltd., Group. Viscount operators in the U.S.A. are already able to purchase Smiths spares from Vickers-Armstrongs, Inc., and this latest agreement will give U.S. operators of the Fairchild F-27, Grumman Gulfstream and D.H. Dove and Heron the same supply facilities.

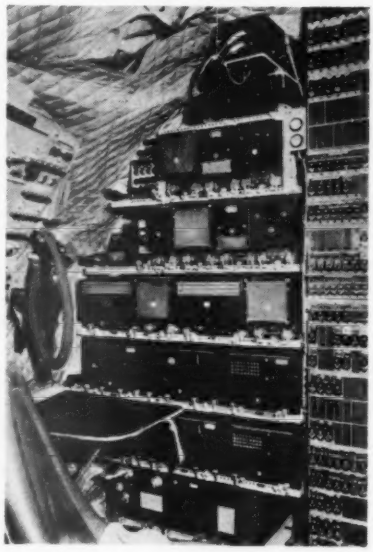
PRODUCTION MOVE.—The Plessey Co., Ltd., is to close down its Rotherham factory which produces wiring equipment for the aircraft industry and transfer production to a factory at Swindon.

TEST-PLANT CORRECTION.—The consulting engineers to Rolls-Royce, Ltd., for the new engine test plant at Derby were McLellan and Partners in association with Merz and McLellan; in THE AEROPLANE of October 3 the name McLellan was incorrectly given as McLennan.

SEATTLE SYMPOSIUM.—The Fifth Annual Test Instrumentation Symposium of the Instrument Society of America is due to be held at Seattle, Washington, from May 4-7, 1959. It will cover both aircraft and missile instrumentation problems and its theme will be "The Systems Approach to Instrumentation." Mr. F. E. Woods (Boeing) will be chairman.

HEADSETS AND HELMETS.—The Industrial Division of Amplivox, Ltd., has recently developed, in conjunction with the R.A.E., a range of communications headsets and helmets. Fitted with miniature acoustic inserts, the equipment covers oxygen-mask and noise-cancelling microphones and earphones. The acoustic inserts are tropicalized and NATO approved.

MATERIALS AT CRANFIELD.—A Department of Aircraft Materials has been established at the College of Aeronautics at Cranfield and in future students will have the option of choosing this subject as their main specialization in the post-graduate Diploma course. Another materials innovation at Cranfield is short courses on materials; these are open to industry generally and will last about two months.



COMET COMMUNICATIONS. — The majority of the radio system in the Comet 4s of B.O.A.C. has been supplied by Marconi's Wireless Telegraph Co., Ltd. The Marconi installation consists of, top to bottom, VOR/ILS equipment, a dual VHF multi-channel transmitter-receiver and two HF multi-channel transmitter-receiver units.

CHANGE OF NAME.—The name of The Aerograph Co., Ltd., has now been changed to The Aerograph-DeVilbiss Co., Ltd., to tie-up more closely with its symbol "Aerograph - DeVilbiss," denoting the company's spray-painting equipment.

Aviation Calendar

October 27.—R.Ae.S. Guided Flight Section lecture, "The Bloodhound," by D. J. Farrar, F.R.Ae.S., at the Institution of Civil Engineers, Great George Street, **London, S.W.1,** at 18.00 hrs.

October 29.—R.Ae.S. Graduates and Students Section, film show, in the library, 4 Hamilton Place, **London,** W.1, at 19.30 hrs.

October 29.—R.Ae.S. Weybridge Branch lecture, "The History of the Supermarine Organization," by A. N. Clifton, B.Sc., F.R.Ae.S. (chief designer, Supermarine Works), at the Apprentice Training School, Vickers-Armstrongs (Aircraft), Ltd., **Weybridge,** at 18.10 hrs.

October 29.—R.Ae.S. Gloucester and Cheltenham Branch lecture, "Landing Hazards on the Moon and the Use of Space Stations," by A. F. Collins, F.R.Ae.S., F.B.I.S., at the High School for Girls, Widemarsh Street, **Hereford,** at 19.30 hrs.

October 29.—Kronfeld Club talk, "Aircraft at Leszno, 1958," by Peter Brooks at 74 Eccleston Square, **London,** S.W.1.

October 29.—R.Ae.S. Hatfield Branch lecture, "Some Recent Developments in Aircraft Casting Manufacture," by R. W. Eade (J. Stone and Co. (Charlton), Ltd.), in the de Havilland Restaurant, **Hatfield,** at 18.15 hrs.

October 31.—Surrey Flying Club, annual dinner and dance, at the Greyhound Hotel, **Croydon,** at 19.30 hrs. for 20.00 hrs.

November 1.—British Interplanetary Society lecture, "Astronomical Measurements with Rockets, Satellites and Balloons," by Dr. R. F. Stebbings (University College, London), in the Tudor Room, Caxton Hall, Caxton Street, **London,** S.W.1, at 18.00 hrs.

November 3.—R.Ae.S. Gloucester and Cheltenham Branch, rotunda (by invitation of the Society of Instrument Technology), "Instruments for Guided Flight," by G. G. Roberts, M.Sc., A.F.R.Ae.S., at St. Mary's College, St. George's Place, **Cheltenham,** at 19.30 hrs.

November 3-7.—Kronfeld Club, exhibition of paintings of gliding and light aircraft, at 74 Eccleston Square, **London,** S.W.1 (18.00 hrs.—22.00 hrs.).

November 4.—R.Ae.S. lecture, "The Spectre Rocket Engine," by W. N. Neat, A.F.R.Ae.S., in the Library, 4 Hamilton Place, **London, W.1,** at 19.00 hrs.

November 4.—R.Ae.S. Luton Branch lecture, "Guided Flight," by L. H. Bedford (English Electric Co., Ltd.), in the Napier senior staff canteen, **Luton Airport,** at 18.15 hrs.

November 7.—R.Ae.S. and Helic. Assn. of G.B. joint lecture, "Development of the Fairey Rotodyne," by Dr. G. S. Hislop, F.R.Ae.S., at the Institution of Civil Engineers, Great George Street, **London,** S.W.1, at 19.00 hrs.

November 7.—A.B.A.C. annual dinner, at the Waldorf Hotel, **London,** W.C.2, at 19.00 hrs. for 19.30 hrs.

November 7.—Kronfeld Club, dinner/dance, at the Eccleston Hotel, Eccleston Square, **London,** S.W.1, at 19.00 hrs. for 19.30 hrs.

Company Notices

NEW COMPANY

Sparkes Bros. (Contracts), Ltd. (612,233).—Private co. Reg. October 1. Cap. £5,000 in £1 shs. Objects: To carry on the business of builders and constructors of roads, aerodromes, landing fields, houses, shops, etc. Permanent directors: Reginald G. Sparkes (chairman), Two Gates, The Avenue, Sunbury, Middx., director of Sparkes Bros., Ltd., etc.; Winifred Sparkes, 66 Lampton Rd., Hounslow, Middx, director of Conallcrete, Ltd., etc.; Arthur T. Cherrett and John B. Thomas. Sec.: L. E. Watts. Reg. off.: 59 Sloane St., London, S.W.1.

INCREASE OF CAPITAL

H. M. Hobson, Ltd. (304,519), Africa House, Kingsway, London, W.C.2.—Increased by £1,000,000 in 5s. shs. beyond reg. cap. of £1,000,000.

New Patents

APPLICATIONS ACCEPTED

805,270.—M.L. Aviation Co., Ltd.—"Releasable attachment devices for use in aircraft."—May 17, 1957. (March 6, 1956.) (Addition to 784,053.)

805,138.—Lear, Inc.—"Indicating instruments for aircraft."—March 1, 1956. (March 28, 1955.)

805,139.—Leduc, R.—"Hydraulic servo-systems."—March 29, 1956. (March 30, 1955.)

805,261.—Birmetals, Ltd., and English Electric Co., Ltd.—"Heat-exchangers."—May 9, 1955. (Feb. 8, 1954.)

805,188.—Korsak, K., and Treleman, L. M.—"Hydraulically pressurized reservoir."—April 5, 1957. (April 20, 1956.)

805,222.—Rolls-Royce, Ltd.—"Aircraft."—June 8, 1956. (June 8, 1955.)

805,442.—Fairey Aviation Co., Ltd.—"Aircraft."—Sept. 28, 1955. (Sept. 30, 1954.)

805,283.—Glenn L. Martin Co.—"Airfoils or the like."—Aug. 20, 1955.

805,126.—Hatfield, J. E.—"Parachute packs."—Aug. 2, 1956. (Aug. 26, 1955.)

Applications open to public inspection on Dec. 3, 1958; opposition period expires on March 3, 1959.

Birth Notices

Brooke.—On October 7, at R.A.F. Hospital, Ely, to Joyce (*née* Mears), wife of Wg. Cdr. B. Brooke—a daughter.

Jeka.—On September 13, to Nancy Eileen (*née* Jones), wife of Flt. Lt. Josef Jeka, D.F.M. (deceased)—a daughter.

Leach.—On October 11, at Glasgow, to Audrey (*née* Inglis), wife of Flt. Lt. G. Leach—a son.

Lockyer.—On October 5, to Sheila (*née* Ransom), wife of Sqn. Ldr. F. R. Lockyer—a daughter.

Tucker.—On October 8, at Norfolk and Norwich Hospital, to Jann (*née* Rees), wife of Flt. Lt. J. A. Tucker—a daughter.